Climate Change Team
Environment Department

THE WORLD BANK

STUDY ON SLOVAK STRATEGY FOR GHG REDUCTION

Bratislava

June 1998

THE WORLD BANK

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with assistance of the World Bank, the Swiss Government and the Harvard Institute for International Development

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Abbreviation	Explanation
AAC	Average Abatement Cost
ABP	Abatement Potential
AEEI	Autonomous Energy Efficiency Improvement
AGR	Annual Growth Rate
AIJ	Activity (Activities) Implemented Jointly
BATNEEC	Best Available Technologies Not Entailing Excessive Cost
CC	Combined Cycles
CDM	Clean Development Mechanism
COP	Conference of Parties to the UNFCCC
CT	Credit Trading
DC	Developed Countries
DECPAC	Software for electric generation system analyses, based on WASP
DH	District Heating
dr	Discount rate
E	Elasticity
$EFCO_2$	Emissions factor of CO_2
EID	Energy Intensity Decrease
EIT	Economy in Transition
ENPEP	Energy and Power Evaluation Program
ER	Emissions Rate
ERU	Emissions Reduction Unit
ES	Emissions Standard
ET	Emissions Trading
EU	European Union
FC	Fuel Consumption
FG	Fuel Gases
FGD	Flue Gas Desulphurisation
GDP	Gross Domestic Product
GHG	Greenhouse Gases: CO_2, N_2O, CH_4, etc.
HFO	Heavy Fuel Oil
HP	Heating Station
HPP	Hydropower Plant
CHP	Combined Heat and Power Plant
IAEA	International Atomic Energy Agency
In	Investment costs
INFOM	Software for electric generation system planning
JI	Joint Implementation
LFO	Light Fuel Oil
MAC	Marginal Abatement Costs
MoE	Ministry of Environment
MoEC	Ministry of Economy
NA	North America
NEIS	National Emissions Inventory System (prepared new version)
NPP	Nuclear Power Plant
NPV	Net Present Value
PC	Pacific Ocean Region
REZZO	Register of Pollutant Sources
SED	Specific Energy Demand
TCEE	Trading Carbon Emissions Entitlements
UNFCCC	United Nations Framework Convention on Climate Change
WASP	Vienna Automatic System Planning
WB	World Bank
WE	West Europe

CONTENT

FOREWORD

Global anthropogenic climate change poses a potentially serious threat to our environment and to humanity. Therefore, recent years have witnessed an intensified international diplomatic effort toward agreement on stabilisation of atmospheric concentrations of greenhouse gases at a level that would, according to the United Nations Framework Convention on Climate Change (UNFCCC), "prevent dangerous anthropogenic interference with the climate system". In August 1994, the Slovak Republic adopted the UNFCCC, which is the first international legal instrument to address this serious issue.

The complexity of climate change issues and the need to monitor compliance with the UNFCCC underscores the need to adopt new, more effective mechanisms and forms of international cooperation. Thus, the transfer, sharing, or trading of emissions credits have been promising as parts of an overall global solution to climate change. To this end, the Third session of the Conference of the Parties adopted the Kyoto Protocol (1997), which calls for transfer of emissions reduction units (Article 6) and allowance trading (Article 17) as new mechanisms to enhance GHG reduction efforts.

The World Bank's sponsorship of the National Strategy Studies for GHG Reduction in countries with Economies in Transition (EIT) has been a key component in assessing the roles of EIT countries in this process. The objectives of these studies include a) development of a proper methodology to examine tradable reduction potential in EIT countries; b) identification of possible positions of individual countries in the emissions market; and c) preparing JI project pipelines. This project could be realized only with the technical assistance and financial support of the Swiss Government, which is also effectively participating in the pilot phase initiatives of Activities Implemented Jointly.

On behalf of the Air Protection Department of the Ministry of the Environment of the Slovak Republic, I thus wish to thank the Swiss Government, the World Bank, and the Harvard Institute for International Development for their assistance and support in the development of this study in Slovakia. As one of the first countries participating in the NSS project, Slovakia has an excellent opportunity to influence international common actions toward GHG mitigation that will enhance protection of the global environment. Successful participation in this process could also bring us the necessary financial resources to overcome barriers for implementing environmentally oriented projects in the Slovak Republic.

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1 Review of existing studies and recent development of GHG reduction

This chapter outlines the evolution of the institutional framework to address climate change. The Slovak Republic acceded to the UNFCCC in August 1994, becoming the 89th Party to the Convention. Slovakia thus accepted the specific obligations resulting from the Convention, including the commitment to take measures aimed at returning emissions of GHG to the base year (1990) level by the year 2000. During the period between the 1994 adoption of the UNFCCC and negotiations to the 1997 Kyoto Protocol, new concepts for GHG mitigation have emerged. These strategies, based on Article 3, Paragraph 3, of the Convention, urge governments to take "…into account that policies and programs to deal with climate change should be cost/effective to ensure global benefits at the lowest possible costs" and notes that "…efforts to address climate change may be carried out cooperatively by interested Parties".

The main objectives of analysis and conclusions in this chapter therefore are:

- ***to describe briefly the climate change institutional framework;***
- ***to discuss the most significant measures in the Kyoto Protocol;***
- ***to evaluate possibilities for implementation of these new GHG mitigation concepts in countries with economies in transition;***
- ***to assess national GHG-related policy in the Slovak Republic and results of existing studies focused on this issue.***

1.1 UNFCCC

In 1990, The United Nations General Assembly established the Intergovernmental Negotiating Committee for a Framework Convention on Climate Change (INC/FCCC). Less than two years later, negotiators from over 150 States adopted the United Nations Framework Convention on Climate Change (UNFCCC) on 9 May 1992 in New York[1]. At the June 1992 United Nations Conference on Environment and Development (known as the Rio "Earth Summit"), 155 countries signed the Convention.

The UNFCCC is the first international legal instrument to address the issue of climate changes caused by anthropogenic emissions of greenhouse gases (GHGs)—mainly CO_2, CH_4, and N_2O. The ultimate objective of this Convention is to achieve stabilisation of GHG concentrations in the atmosphere at a level that would "prevent dangerous anthropogenic interference with the climate system." Furthermore, the Convention stipulates that this level should be achieved within a time frame sufficient to allow ecosystems to adapt naturally to climate change, to ensure that food production is not threatened, and to enable economic development to proceed in a sustainable manner. To achieve the objective of the Convention, the Parties are guided by five main principles (Article 3) listed in APPENDIX 1.

The Slovak Republic acceded to the UNFCCC on August 1994, thus becoming the 89th Party to the Convention. The Convention came into effect in the Slovak Republic on November 1994. Under the provisions of the UNFCCC, industrialised countries undertake several specific commitments. Most members of the Organisation for Economic Cooperation and Development (OECD) plus the states of Central and Eastern Europe—together known as Annex I Parties—are committed to adopt policies and measures aimed at returning their greenhouse gas emissions to 1990 levels by the year 2000. The Slovak Republic also accepted this specific obligation.

BOX 1

Relevant terms and definitions [6,29]:

AIJ	GHG reduction projects implemented in some UNFCCC Parties (developing countries or EITs) and funded by other Parties (OECD countries) without any emissions credits. It is a pilot phase of future Joint Implementation, which should be evaluated by year 2000.
Allowance	The total allowed emissions from a controlled entity (country, sector, or source). Granted right to emit a defined quantity of GHGs over certain period of time.
Annex I	List of industrialised countries (OECD and EITs) having specific obligations under the UNFCCC.
Banking	A system enabling emissions permits not needed for compliance in the current period to be saved for compliance or sale in a future period.
Baseline	Reference emissions level or projection of emissions in the absence of mitigation policies and measures ("business as usual" scenario).
Borrowing	The option for a Party to exceed its current emissions limit provided it makes corresponding reductions in the next period.
CEU	Carbon Equivalent Unit – a proposed traded commodity in international GHG emissions trading system.
COP	Conference of the Parties to the UNFCCC.
Credit	A verified emissions reduction achieved through a specific JI project.
Differentiation	Allocation of different emissions caps or quotas in accordance to accepted criteria (e.g. emissions per GDP or capita, economic development, structure of energy carriers, etc.)
Emissions budget	Quotas or caps to emissions aggregated over a period of several years.
Emissions cap	An aggregate emissions limit, legally binding for a country (sector, source) in given period of time.
Emissions trading	The buying and selling of emissions allowances, entitlements, offsets or credits either directly between controlled entities or indirectly via intermediaries (brokers, exchanges, etc.).
Flat rate	Equal (not differentiated) QELROs.
"Hot Air"	"Hot Air" may occur if a country was allocated an emissions limit above its actual or anticipated level of emissions.
Host country	A country in which territory a JI project is located.
Investor country	A country investing in JI project located in a host country.
IPCC	Intergovernmental Panel on Climate Change.
Joint Implementation	Concept allowing Parties to fulfil their emissions obligations jointly; sometimes refers to a system allowing the earning of emissions credits via investment in emissions reductions from a specific JI project.
Offset	A quantified emissions reduction achieved via investment in an uncontrolled source.
Permit	A marketable instrument giving the right to emit a quantified amount of GHGs and related to the individual emissions sources.
Protocol	A legal instrument to the UNFCCC containing QELROs and eventually common policies and measures for Annex I countries (non-Annex I may accept QELROs voluntarily).
QELROs	Quantified emissions limitation and reduction objectives (reduction targets and timetables).

1.2 *Evolution of the Climate Change Institutional Framework*

The UNFCCC designates the Conference of the Parties the "supreme body of the Convention that shall keep under regular review the implementation of the Convention and any related legal instruments that the Conference of the Parties may adopt." The first Conference of the Parties to the UNFCCC (COP-1) took place in Berlin (March 28–April 4, 1995). Non-OPEC Parties agreed on the inadequacy of current Convention commitments and the consequent need for clarification and enhancement of the Convention. The most important result of this Conference was drafting of the so-called Berlin Mandate to outline broad responsibilities and to prepare a protocol for GHG emissions reduction after the year 2000. The Ad Hoc Group on the Berlin Mandate (AGBM) was responsible for preparing the text of this Protocol to be adopted at COP-3 in Kyoto. The second Conference of the Parties (COP-2), held in Geneva, focused on the details of how to move from this start at COP-1 to a fruitful COP-3 in Kyoto, which was to provide the Parties with a legally binding document that would significantly strengthen the commitments of Annex I Parties.

1.3 *The Kyoto Protocol*

The third session of the Conference of the Parties took place from 1–11 December 1997 in Kyoto. The large differences in initial negotiating positions suggested that the chances of a successful agreement were small; however, Parties were able to agree on a set of measures governing reduction of Annex I GHG emissions and adopted them within the Kyoto Protocol. The emissions limitations targets (QELROs) listed in the Kyoto Protocol[2] are summarized in Table 1.1:

Table 1.1. Quantified emissions limitation or reduction commitment, COP-3

Quantified emissions limitation or reduction commitment (percentage change from base year period)	***Country***
110	Iceland
108	Australia
101	Norway
100	New Zealand, Russian Federation, Ukraine
95	Croatia
94	Canada, Hungary, Japan, Poland
93	United States of America
92	Austria, Belgium, Bulgaria, Czech Republic, Denmark, Estonia, Finland, France, Germany, Great Britain, Greece, Ireland, Italy, Liechtenstein, Latvia, Lithuania, Luxembourg, Monaco, Netherlands, Portugal, Romania, ***Slovak Republic,*** Slovenia, Spain, Sweden, Switzerland

Source: FCCC/CP/1997/L.7/Add.1, Annex B

The Kyoto Protocol's inclusion of some form of Joint Implementation with crediting and emissions trading as vehicles for mitigating GHG emissions forms the basis for this study.

Excerpts from FCCC/CP/1997/L.7/Add.1 regarding joint implementation, the Clean Development Mechanism, and emissions trading are listed in Appendix 1.

BOX 2
GHG emissions reduction titles in the Kyoto Protocol[31]

Under the title of "flexibility" (for Annex B countries in meeting their quantified limitation or reduction commitments under Article 3 of the Protocol), negotiators included three articles in the Kyoto Protocol (FCCC/CP/1997/L.7/Add.1, see APPENDIX 1 for complete texts of these articles) and took some decisions on the modalities of for each instrument:

- Article 6 allows the transfer of "emissions reduction units" from one Annex I Party to another. This transfer is essentially Joint Implementation with crediting, although the term "joint implementation" is not used explicitly. According to this Article, JI with crediting (the "transfer of emissions reduction units") is allowed for Annex 1 Parties. Projects to reduce anthropogenic emissions or to enhance anthropogenic removals by sinks are eligible as JI projects. In addition, the Article defines four conditions for transfer of ERUs: (a) project approval by Parties, (b) environmental additionality, (c) compliance with modalities for inventories and reporting, and (d) the condition that transfers must be supplemental to domestic actions (for complete text, see Annex 1). These rules suffice to conduct such transfers, although guidelines may be further elaborated. Finally, intermediaries can be authorized by Parties to generate or conduct such transfers.

- Article 12 defines a "clean development mechanism" (CDM) under which Annex I Parties may accrue "certified emissions reductions" (CERs) that can contribute to meeting their individual commitments. This CDM is essentially a fund for joint implementation (broadly defined). CDM is designed to assist non-Annex 1 Parties both in achieving “sustainable development” and in contributing to the objective of the UNFCCC; in addition, it will allow Annex 1 Parties to concomitantly reduce their emissions reduction/limitation burdens. Thus, Annex 1 Parties can use the CERs accrued through the CDM to meet their commitments. Emissions reductions shall be certified by operational entities designated by the COP/MOP on the basis of three criteria: voluntary participation; real, measurable and long-term benefits related to the mitigation of climate change; and environmental additionality. The COP/MOP shall elaborate modalities and procedures at its first session. Certified emissions reductions can accrue beginning in the year 2000. A share of the proceeds from project activities shall be used to finance adaptation measures in particularly vulnerable developing countries. Institutionally, the CDM will be subject to the authority/guidance of the COP serving as the MOP and be supervised by an executive board.

- Article 17 refers to allowance trading. According to this Article, Annex B Parties may participate in emissions trading to fulfil their commitments, as long as such trading is supplemental to domestic actions. The COP shall define principles, modalities, rules and guidelines for emissions trading.

1.4 GHG Mitigation Options - Development of New Basic Concepts

1.4.1 Joint Implementation

The concept of Joint Implementation (JI), first introduced by Norway into the negotiations of the UNFCCC in 1992, is anchored in Article 4, Paragraph 2(a) of the Convention: "*…developed country Parties and other Parties included in Annex I …implement such policies and measures* (on the mitigation of climate change, by limiting its anthropogenic emissions of GHGs and protecting its GHGs sinks and reservoirs) *jointly with other parties and may assist other Parties in contributing to the achievement of the objective of the Convention…*"

The cost effectiveness of specific emissions abatement policies and measures differs significantly among regions and countries; the least-cost measure or mix of measures in one region or country will not necessarily be cheap in another. The prime determinant of cost-effectiveness is the existing infrastructure for producing and delivering energy services, such as transportation and various electricity end-uses. Substantial technical-economic differences exist among Annex I and non-Annex I countries, such as in the structure and pattern of energy demand, fuel mix, technology mix, age and replacement rate of capital stock, and import and export balances.

From an economic point of view, JI is based upon the difference of the abatement costs, which are markedly higher in the more energy-efficient industrialised countries than in countries with economies in transition (EIT) or developing countries. In this sense, JI is defined as cooperation between two countries—the investor country and host country. Under a JI scheme, an investor country, where the costs of CO_2 abatement are higher than in the host country, invests in GHG abatement in the host country. Subsequently, the investor country receives credit, in whole or in part, for emissions reductions in its own national GHG emissions account (Barret 1994, Boehm 1994).

The exchange of potential benefits (*e.g.*, technology transfer and local economic benefits including training, new or improved infrastructure, improved energy services, environmental and human health benefits[28]) between host and investor countries provides a real incentive for JI implementation. Cross-border cooperation will therefore be more cost effective than if all Parties to the Convention would fully meet their commitments by independent abatement measures within their own borders.

Barret (1992)[32] has estimated that implementation of the EU target on stabilising EU-wide CO_2 emissions at the level 1990 by 2000 would be 50 times less expensive in 2000 under JI than if each member state were forced to independently stabilise its own emissions[6]. Although JI is anchored in the UNFCCC, the operational requirements for an international JI regime are still not resolved. JI is a relatively new and developing concept and UNFCCC leaves to the COPs the duties of drafting criteria and rules to govern JI projects.

Assessment of JI project credits depends on an estimate of project baseline—that is, the level of emissions that would ensue given no JI project. Emissions reductions are calculated from the difference between two emissions levels: project baseline and project performance. Because it is inherently a hypothetical exercise, establishing the baseline in a transparent and verifiable way can be difficult. This type of JI project is therefore more laborious, which—together with monitoring and verifying of the individual projects—can increase total operating costs. A further complication arises with so-called "leakage effects," in which emissions abated at one site because of a JI project may simply be shifted to another site within the same country. JI is therefore dependent upon development and implementation of verifying and monitoring mechanisms as well as upon a reliable system of national GHG inventories (Heister 1996).

1.4.2 *Objections to JI*

In preparing for COP-1, developing countries (G-77 and China) objected to the elements of JI that they saw as a means for Annex I Parties to avoid domestic abatement actions to meet their obligation under the FCCC (Mitchell 1996). Specifically, several questions have been raised during the negotiations (Dudek and Wiener 1996, Mitchell 1996):

- JI would transfer emissions reduction obligations from developed to developing countries;
- JI would limit economic development as well as the political sovereignty of poor countries (and would thus represent a form of eco-imperialism);
- JI would deplete stock of low-cost reductions available to the host countries ("low-hanging fruits", thereby increasing future abatement costs to the host countries);

These objections are additional to debates on cost-effectiveness, high transaction costs and investment risks.

A number the environmental organisations also recalled the guiding principles that have shaped the development of the UNFCCC and which will form the basis of a politically acceptable mechanism for JI. For example, Greenpeace highlighted the following concerns (Greenpeace 1994):

- *Additionality*. JI should be additional to the obligations of Annex II countries to transfer capital and technology to developing countries and to pay full incremental costs of measures to mitigate climate change, and it should be additional to projects that would have been carried out anyway;
- *Equity*. JI projects should be socially acceptable and contribute to local socio-economic development and capacity building;
- *Transparency*. JI project development should involve the local community, NGOs, and interested parties to ensure that the full range of local social, economic and environmental costs and benefits can be considered[6].

Due to the confusion surrounding JI, political resistance to the crediting of emissions reductions and a lack of operational criteria and common methodologies (Berlin 1995), COP-1 decided to "establish a pilot phase for Activities Implemented Jointly[6,28] (AIJ) among Annex I Parties and, on voluntary basis, with non-Annex I Parties" (COP-1, Decision 5/CP.1)[6,28]

1.4.3 *Activities Implemented Jointly*

AIJ grew out of the concept of Joint Implementation, which, though not explicitly defined, introduced the idea of international co-operation among all Parties to the Climate Convention in order to stabilise atmospheric GHG concentrations. The first Conference of the Parties established AIJ as a pilot phase to define a permanent program of "Joint Implementation". It took its mandate from the principle, defined in the FCCC, that Parties should protect the climate system "*… on the basis of equity and in accordance with their common but differentiated responsibilities and respective capabilities. Accordingly, the developed country Parties should take the lead in combating climate change and the adverse effects thereof*" (Article 3). In particular, although the aim of returning emissions to 1990 levels (Article 4.2) applies only to Annex I Parties, Article 4.1 further calls on *all* Parties, including developing country Parties, to formulate and implement programmes to mitigate climate change and facilitate adaptation to climate change.

While AIJ's primary purpose is to reduce emissions of greenhouse gases and to enhance carbon sinks, AIJ has the potential to bring new and additional financing from developed country sources to developing countries and facilitate the economic growth of participating developing countries. As a policy instrument, AIJ can encourage new investments consistent with the local development objectives of project-site countries. Developing countries are in the process of adopting national policies and measures to reduce greenhouse gases to achieve their commitments under the UNFCCC. AIJ is potentially one of the most cost-effective methods to abate greenhouse gas emissions; as mentioned earlier, AIJ projects can result in more GHG emissions per dollar invested.

However, during the present AIJ pilot phase, no emissions reduction credits can be awarded to investors[28]. Each COP is charged to "review the progress of the pilot phase…with a view to taking appropriate decisions on the continuation of the pilot phase", but a conclusive decision on the pilot phase is to be made before 2000. Decisions of COP-1 on activities implemented jointly under the pilot phase are listed in APPENDIX 1.

In accordance with the decision of COP-1, AIJ projects should demonstrate *additionality*. Specifically, projects need to meet two additionality criteria:

- <u>Environmental additionality.</u> An AIJ project should generate GHG mitigation benefits which would not have occurred in the absence of the AIJ instrument
- <u>Financial additionality.</u> The financing of such activities shall be additional to the already existing financial obligation of Annex I Parties;

The number and size of AIJ projects currently implemented under the pilot phase is relatively small. As of mid-1997, 40 AIJ projects (FCCC/SBSTA/1997/INF.1) have been or are being initiated covering a range of sectors in developing and EIT countries[28]. These projects have begun in the host countries of Belize, Bhutan, Costa Rica, Czech Republic, Ecuador, Estonia, Honduras, Hungary, Latvia, Mexico, Nicaragua, Poland, Romania, the Russian Federation, and Uganda.

Three stages exist for which the objectives of AIJ and the issues of incentives and institutional capacity should be discussed:

- The AIJ pilot phase in its current form;
- An enhancement of the remainder of the AIJ pilot phase after a post-Kyoto decision on the Berlin Mandate (QELROs); and
- A fully operational JI programme in which Annex I and/or non-Annex I countries receive credits for investment in emissions reductions made outside the investing country.

A process similar to the effort of AGBM to develop a Kyoto Protocol will likely be launched to develop the conditions for JI and emissions trading. The possible steps for sequence of GHG mitigation concepts could therefore be illustrated as:

AIJ ⇒ bilateral JI credits trading ⇒ multilateralized JI credits trading ⇒
global emissions trading ("cap and trade")

In this scheme, the current AIJ pilot phase would lead to a similar bilateral JI credit transfer scheme recognized under the Kyoto Protocol. This system could then be extended to allow multilateral JI investments and credit transfer, which could in turn make the transition to a global emissions trading regime.

1.4.4 International GHG Emissions Trading

Emissions trading is a relatively new concept originating from JI between Annex I Parties committed to reduction targets (QELROs) (Baron and Mullins 1996, Anderson et al. 1997). If one country emits less than the given emissions cap, it is allowed to sell the difference between the actual emissions and the cap. These emissions permits can be bought by a second Annex I Party whose emissions exceed its target for that period. In this case only aggregated (net) emissions are monitored via national emissions inventories.

Emissions trading and JI are therefore two complementary options to increase efficiency of GHG mitigation based upon the differences of abatement costs between countries (ECON 1997, Mullins 1997). JI is currently understood as a trading of emissions reductions based on an individual project. Emissions trading is simply JI on a national level where the funding is not linked to specific projects. This emissions trading concept is frequently combined with banking or borrowing of the emissions permits to enhance the overall flexibility of the system. While the first concept (JI) enables the cooperation between Annex I and non-Annex I countries, which have not adopted emissions caps, the second one leads to lower administrative, compliance and transaction costs. In theory, both concepts (originating from the UNFCCC) could be combined into one effective international market for GHG emissions reductions (Joshua 1997).

The creation of this tradeable commodity can be sketched as follows[23]:

Surplus ("unused") carbon equivalent units (the tradeable commodity)	=	National emissions limit (based on QELROs)	-	Actual emissions (inventory reports)

The most important factors to consider when preparing transaction rules, monitoring and compliance procedures, and institutions for trading are listed below.

- National QELROs and amount of tradeable commodity
- What can be traded (*i.e.*, can Parties trade all GHGs, sources and sinks or only those that can be well monitored?)
- Length of budget period
- Flexibility for system enlargement (*e.g.* adding Parties, GHGs, sources, or sinks)
- Banking (Saving of emissions permits not needed for compliance in the current period to be used for compliance or sold in future period)
- Borrowing (Party can exceed its current emissions limit provided corresponding reductions are made in the next period)
- "Hot air" (may occur if a country were allocated an emissions limit above its actual or anticipated level of emissions)
- Fairness and liability
- Domestic policies and measures (contributions from trading to the GEF or another established fund for future damages caused by climate change, or for insurance?)

The main differences between allowance and credit trading are briefly compiled in Table I.1 in APPENDIX 1.

1.5 GHG Mitigation Options in EIT Countries

The Slovak Republic's share of global anthropogenic GHGs emissions is approximately 0.2%. The annual per capita CO_2 emissions of approximately 11 tonnes (1990) is lower than the OECD average (IPCC/OECD 1992) but higher than the average for Western European countries (8 tonnes per capita) and the world average (4 tonnes per capita). This amount places Slovakia among the 20 states with the highest per capita emissions.
Because of to their past economic development, EIT countries generally show high GHG emissions compared to the OECD average for a number of categories (cumulative emissions, emissions per capita, emissions per unit of GDP, etc.). Moreover, three EIT Annex I countries—the Russian Federation, Ukraine and Poland[3,6]—are among the 15 largest CO_2 emitters.

Since 1988, CO_2 emissions decreased in EIT countries, leading to their current global share of 18% (Mullins, et al.). This sharp fall has resulted primarily from the collapse of the former COMECON market, which led to widespread decommissioning of energy intensive industries in the region. In the short term, therefore, EIT countries' GHG emissions are likely to be well below 1990 levels. However, the economies of Annex I EIT countries are changing rapidly and GHG emissions are forecast to rise steeply as EIT countries make the transition to a market economy[30].

GHG emissions in these countries could rise steeply in the future unless energy efficiency and other measures can break the correlation between GDP growth and GHG emissions. Energy efficiency often provides the most cost-effective opportunities for GHG reduction and energy supply. Currently, only a small portion of total finance that goes to EIT countries is spent on energy efficiency. The EBRD conservatively estimates that the value of energy efficiency opportunities with less than a 3.5 year payback period in EIT countries is more than 52 billion USD at current energy prices[32]. Normally, investors would consider investment opportunities such as these to be very attractive. However, at present investment flows are not sufficient to provide this amount of finance.

Over the last five years, private sector finance has increased globally while public sector aid has generally declined. Private capital flows to emerging markets increased dramatically during the 1990s, but many EIT countries have not been able to attract significant amounts of private sector investment. Even the relatively small level of finance that is currently available in EIT countries is not dispersed to projects efficiently because of barriers in identifying, developing, managing, and financing investment projects.

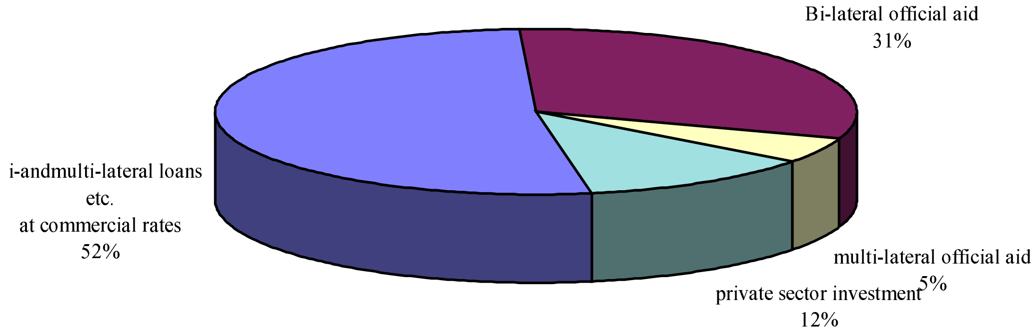
Government policies can significantly influence macro-economic conditions such as unemployment, inflation levels, and budget deficit. Economic trends and the macro-economic and legislative policies of EIT countries form the basis for the local investment climate[30]. In the energy sector, low prices, uncertainty over privatisation of utilities, and general instability of prices continue to deter investors. Many EIT countries still need to reform their energy sectors by privatising state-controlled elements, removing energy subsidies, and providing the market structure and regulations needed for competition between energy suppliers.

The lack of investment given the size of opportunities that exist indicates the main barriers to financing energy efficiency that can be classified in six areas:

- macro-economic conditions
- lack of information and experience
- lack of credit history
- weak institutions and unclear or common ownership
- small-scale nature of efficiency projects
- low and uncertain energy prices[30]

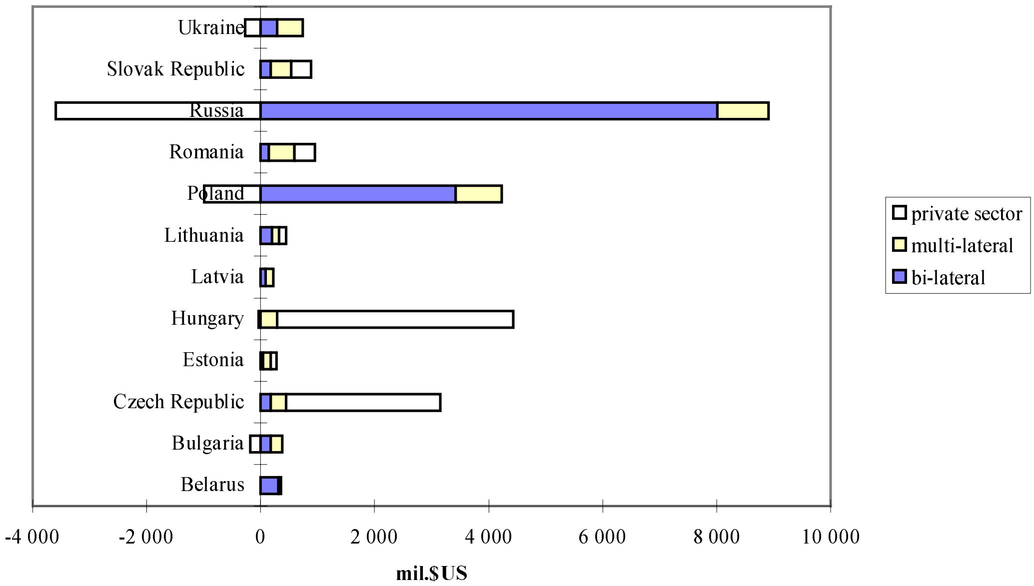
The private sector could have a powerful influence on investment in EITs, but as Figure 1.1 shows, private capital provided only 12% of total external finance in EIT countries in 1995. (World Bank 1996:136). Figure 1.2 gives a more detailed comparison of the financial flows to and from individual EIT countries.

Figure 1.1 Private, bilateral and multi-lateral finance to EIT Countries in 1995[30]



Source: OECD/DAC, 1997

Figure 1.2. Financial flows to EIT Countries in 1995



Source: OECD/DAC, 1997

Thus, in spite of convenient macro-economic conditions high economic liberalisation in the Slovak Republic (with liberalisation index of 8.5 in 1995), the share of financial flows to our country was very low compared to the other EITs.

Carbon intensive fuels dominate the energy supply in many EIT countries. In addition, energy is used less efficiently in EIT countries than in other Annex I countries. This large potential for cost-effective GHGs mitigation in EIT countries could be economically significant; assessing the feasible reduction potential of different sectors and calculating abatement costs for different types of projects is therefore important.

1.6 Policy and Measures to Reduce GHG Emissions in SR - Review of Existing Studies

The Slovak Republic has not yet adopted an integrated strategy on GHG mitigation. However, many environmental protection measures implemented since 1990 (focused primarily on energy conservation and air protection) have had ancillary benefits of GHG mitigation and sink enhancement. The First[4] and Second National Communication on Climate Change[5] and the Country Study of SR[3] present detailed explanations of measures encompassed by present environmental legislation and energy conservation policy. The next section briefly reviews the main input data, key assumptions, and critical points of the First and Second National Communication.

1.6.1 The First National Communication on Climate Change, SR 1995

<u>Input data sources:</u>

- Fuel consumption - Energy Strategy and Policy of the SR up to the year 2005, MoEC SR 1993
- Scenarios of GDP development - Institute for Forecasting, SAS
- Scenarios of Energy Intensity development (PES/GDP) - EGU Bratislava
- Scenarios of final energy consumption.

<u>Key assumptions:</u>

Table 1.2 Key assumption for scenarios of PES consumption

	1990	1995	2000	2005
GDP				
[bill. Sk]	232.1	178.3	204.8	238.6
Share of the year 1990	100%	77%	88%	103%
Primary energy sources (PES)				
[PJ]	941	822	891	936
Share of the year 1990	100%	87%	95%	99%
Fuels [PJ]	781	661	681	725
Share of PES	83%	80%	76%	77%
Electricity [PJ] [1]	28	26	13	14
Share of PES	3%	3%	1%	1%
Primary nuclear heat [PJ] [2]	132	135	197	197
Share of PES	14%	16%	22%	21%
Energy intensity				
[PJ/bill.Sk]	4.05	4.61	4.35	3.92
[toe/thous.USD] [3]	1.74	1.98	1.87	1.69
Share of the year 1990	100%	114%	107%	97%

[1] *import and hydropower plants* [2] *heat released in nuclear reactor*

[3] *in market constant prices and rate of exchange 1990*

Source: The First National Communication.on Climate Change, Slovak Republic, 1995

Implemented measures:

- Increased share of gas consumption for end-uses and for electricity production in combined cycles
- Decreased fossil fuel consumption (by 32 PJ) due to energy saving measures
- Use of nuclear power plant Mochovce.

Scenarios:

- Scenario A – autonomous development of CO_2 emissions creation
- Scenario B – based upon the energy strategy and policy data corrected for transportation sector
- Scenario C – similar to scenario B, but further CO_2 emissions reductions in transportation sector by 10% and maximum energy consumption savings at the level of about 50 PJ by 2005
- Scenario D – similar to scenario C, but entire fossil fuel reduction potential of approximately 126 PJ is realized by 2005.

The main criticisms of the reviewed study:

- Economic development of SR was assumed to result from industrial restructuring similar to that one in developed western countries, but assuming that therefore GDP will be also created in the same way as in these countries (increased share of services, decreased share of energy intensive productions) is incorrect.
- The Report did not use existing models for fuel consumption modelling; the projections used for analysis were therefore provided by individual sectors or extrapolated from GDP creation.
- CO_2 emissions data were based only on default emissions factor values. Aside from not corresponding to real values, the level of CO_2 emissions production was lower not only for the base year 1990, but also for the other ones.

Curves of CO_2 emissions development for the scenarios described above are illustrated in Fig. AI.1 in APPENDIX 1.

1.6.2 The Second National Communication on Climate Change, SR 1997

Input data sources:

- GHG inventory, prepared in the framework of Element I Country Study of Slovakia
- GHG Inventory carried out in Element I
- Energy Statistics of Period 1980–1992 issued by FSÚ (Federal Statistics Office Praha)
- Energy Policy and Strategy of Slovak Republic up to date 2005
- Energy Policy and Strategy of Slovak Republic, updated version for period 1993–2010
- National Emissions Inventory REZZO
- First National Communication on Climate Change of SR, 1995
- Macroeconomics Forecast for Period 1995–2010
- Yearbook of Slovak Power Plants (Roèenka Slovenských elektrární, a.s.)

Key assumptions:

Table 1.3 Key assumptions used for CO_2 emissions modelling

Parameter	***Unit***	***1995***	***2000***	***2005***	***2010***
Fuel and energy carrier prices					
Brown coal domestic [2]	SKK/GJ	73.88	83.69	97.92	102.46
Annual growth rate	%		2.52	3.19	0.91
Brown coal import [1]	SKK/GJ	68.32	70.04	71.81	73.62
Annual growth rate	%		0.50	0.50	0.50
Hard coal import [1]	SKK/GJ	50.25	51.52	52.82	54.15
Annual growth rate	%		0.50	0.50	0.50
Crude oil import [1]	SKK/GJ	100.58	111.60	123.82	137.38
Annual growth rate	%		2.10	2.10	2.10
Natural gas [1]	SKK/GJ	102.44	113.65	126.10	139.91
Annual growth rate	%		2.10	2.10	2.10
NG for district heating [3]	SKK/GJ	51.79	unregulated	unregulated	unregulated
Nuclear fuel [1]	SKK/GJ	14.31	18.17	23.08	29.32
Annual growth rate	%		4.90	4.90	4.90
Centralised supply heat for district heating [3]	SKK/GJ	140	170	unregulated	unregulated
Electricity					
Import	SKK/kWh	1.41	1.61	1.84	2.11
Electrical heating [3]	SKK/kWh	0.44	unregulated	unregulated	unregulated
GDP (stable prices 1984)	bill.SKK	213	281	364	462
Inhabitants [4]	millions	5.366	5.486	5.600	5.676
Primary energy sources [1]	PJ	728	820	902	970
Index of steel production [4] 1995 =100%	%	100	102	101	100
Index of electricity production [1] 1995 = 100%	%	100	112	123	132
Index of centralised heat supply [1] 1995 = 100%	%	100	100	101	98

Sources:

1 *Energy Policy and Strategy of Slovak Republic, up-dated version for period 1993-2010*
2 *Input data from INKO a.s. used at* [1]
3 *Decree on prices, Ministry of Finance of SR, 1996*
4 *P.Kárász, J.Renèko: Macroeconomics Forecast for Period 1995-2010, Prognostic Institute of the Slovak Academy of Sciences, Bratislava, December 1995*

Additional key assumptions

- Scenarios of GDP development in individual sectors
- Scenarios of primary energy consumption
- Assumption of energy intensity development in industry, used in scenario 4
- Assumption of energy and fuel prices development
- The higher scenario of GDP development. This higher scenario is not attractive from the CO_2 emissions point of view, but allows better analysis of individual measure's impact
- Assumption of steel production in Slovak

- Assumption of district heat consumption [TJ/year], supplied from the centralised sources, and the development of price deregulation
- Assumption of electricity production/consumption [GWh/year]
- Optimistic scenario of population development

<u>Implemented legislation and regulatory measures to mitigate CO_2 emissions:</u>

- *Act on Protection of the Air Against Pollutants*, containing the emissions concentration limits of basic effluents (SO_2, CO, NO_x, and solid particles). This regulatory measure is expected to stimulate the retrofitting and repowering of utility energy sources as well as fuel switching for industrial energy sources and for heat supply sources in residential, commercial and other sectors.
- *Energy conservation policy* (in agreement with the prepared legislation) will focus on energy conservation and on decreasing energy intensity both on the supply and demand sides of the energy system, including measures in transportation sector.
- *National energy policy* (updated energy strategy and policy up to the year 2005/2010) is focused on the security of electricity supply system. An integral part of this policy is the replacement of retired nuclear power plant units by new ones and the implementation of new hydropower units. These measures should result in decreased CO_2 emissions.

The following scenarios were applied to the aggregate energy sector model:

Scenario 1 Baseline scenario in which the requirements of emissions limits according to the Act on Air Protection are applied in the case of new energy sources only;

Scenario 2 Full application of the Act on Air Protection; emissions limits for all sources (new and existing) are considered;

Scenario 3 Similar to Scenario 2, but includes the impact of energy saving measures, stimulated by current and proposed legislation. The following measures are be applied:

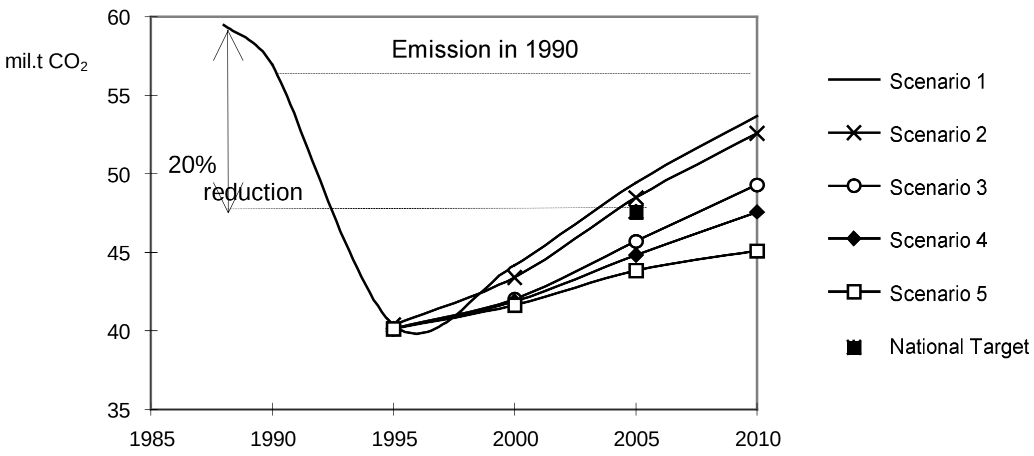
- demand side management;
- energy saving measures in space heating in residential and non-residential buildings;
- measures applied to the transportation sector that will reduce fuel consumption;
- continual casting in metallurgy enterprise VS□ Košice;
- combined cycle implementation in metallurgy enterprise VS□ Košice.

Scenario 4 Similar to Scenario 3, but includes the impact of more extensive industrial restructuring. This restructuring is characterised by technology innovation and reconstruction resulting in 1% annual decreases of industrial energy intensity after 1997.

Scenario 5 Similar to Scenario 4, but includes more intensive use of renewable energy sources. This scenario is not based on the results of energy supply-demand modelling; rather, it is based on the assumption of continual renewable growth to their full potential of 32.4 PJ by 2010. This renewable energy potential is based on data from the Energy Strategy and Policy. Assuming that the renewable energy sources will replace fossil fuel sources, this potential represents 2,473 $GgCO_2$

Creation of energy-related CO_2 emissions is directly influenced by fossil fuel consumption. The developments of energy-related CO_2 emissions for different scenarios are illustrated in Figure 1.3.

Figure 1.3 Energy-related CO_2 emissions



Source: The Second National Communication on Climate Change, The Ministry of Environment of SR, Bratislava 1997

Assumptions of GDP structure conservation as well as the optimistic variant of GDP creation were used for modelling. These assumptions could be significantly influenced by full energy price liberalisation and, potentially, future carbon tax implementation. Application of these measures should result in decreasing energy intensity (especially in chemistry, metallurgy and building material) and thus lower GHG emissions.

Compared to the scenarios elaborated in the First National Communication[4], this set of projections is less optimistic but probably more robust as it is based on detailed analysis of sectoral emissions creation development using real emissions factors of fuels. The critical sectors for CO_2 emissions in SR have been identified by previous analyses as:

- public energy supply
- transportation sector
- industrial fuel consumption

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2. *CURRENT AND PROJECTED CO_2 EMISSIONS IN SLOVAKIA*

The main objectives of this chapter can be briefly described as follows:

a) To analyse GHG emissions development in the transition period and determine the main decisive sector for implementation of GHG mitigation options;

b) To devise possible baseline scenarios, e.g. scenarios without any measures selectively focused on GHG mitigation;

c) To select the most convenient scenario for additional analyses of GHG mitigation and possible emissions trading (credit or/and allowance trading) from analysed ones.

GHG emissions production in Slovakia has decreased during the transition period due to economic slowdown. CO_2 emissions contribute 80% to the total emissions aggregated by means of GWP values in Slovakia. Furthermore, 95% of CO_2 emissions are from fossil fuel combustion and transformation processes.

To estimate the shares of emissions and a baseline for credit and/or allowance trading, projection has been focused on energy-related CO_2 emissionss only. The following assumptions were applied for scenario modelling:

- *High and low GDP scenarios, using GDP growth rate data disaggregated to the individual sectors;*
- *High and low nuclear energy use, considering the installed capacity of a new nuclear power plant at the level 4 x 440 MWe (high option) or alternatively 2 x 440 MWe (low option);*
- *To evaluate the impact of new emissions standards for SO_2, NO_x, CO and solid particles, fuel switching and/or combustion technology changes were considered;*

For individual scenarios we must consider the following limitations to CO_2 emissions reduction:

1) *A reduction in energy-related CO_2 emissions by 8% (relative to the 1990 level) can be achieved only with the low GDP scenarios that include all fuel switching and combustion technology changes stimulated by adopting the new emissions standards;*
2) *The scenarios with low nuclear energy use indicate an increase in NG as the electricity sector switches to combined cycle generation. NG import limitations could therefore become a restriction on the possibility of implementing the CO_2 mitigation options based on fuel switching (coal to gas);*
3) *With a low GDP scenario the option of high nuclear energy use is less realistic since financial resources are more limited;*
4) *To create some CO_2 emissions offset with the high GDP scenario, the following conditions are likely necessary:*
   -High nuclear energy use, e.g. installation of 4 x 440 MWe in the new nuclear power plant
   -Additional autonomous energy efficiency improvement by 5% over baseline in the industrial sector

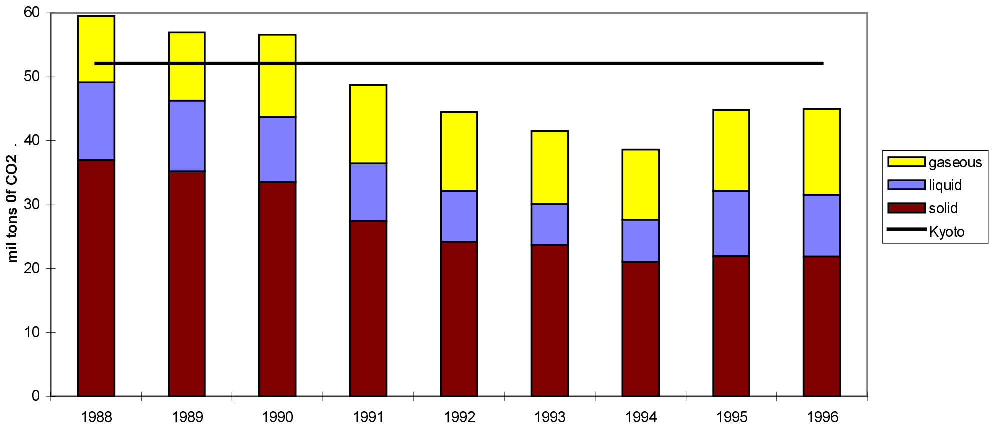
These last assumptions were applied to the baseline scenario used for analysis of GHG mitigation options (Chapter 5).

2.1 *Emissions Of CO_2 In Slovakia During The Transition Period*

In the Slovak Republic, as in other EIT countries, economic slowdown has brought a decrease of energy-related CO_2 emissions. The annual emissions inventories presented in the First and the Second National Communication of the Slovak Republic for the years 1990–1995 were structured in accordance with the IPCC 1995 Guidelines for National Greenhouse Gas Inventories. During that period, CO_2 emissions contributed 80% to the total emissions aggregated by means of GWP values (GWP values recommended by IPCC were used); methane and nitrous oxide emissions contributed 14–15% and 4–5%, respectively, to total GWP-weighted emissions.

A substantial part of CO_2 emissions in Slovakia is related to combustion and transformation processes and therefore this study deals above all with *energy-related emissions of CO_2*. Energy-related CO_2 emissions, according to the IPCC, represent CO_2 released by fossil fuel combustion and transformation. Thus, this definition includes fossil fuel combustion in energy and industry as well as fossil fuel conversion in technology processes (metallurgy, chemistry, etc.). The structure of CO_2 emissions indicates that non-combustion industrial sources represent about 5% of total CO_2 emissions, while energy-related CO_2 emissions represent approximately 95% of the total amount. Projections of CO_2 emissions development in the future have therefore mainly concentrated on energy-related emissions. Figure 2.1 depicts CO_2 emissions for the years 1990–1996 as well as the CO_2 emissions baseline for the year 2010 under the Kyoto Protocol (8% lower than the 1990 emissions level).

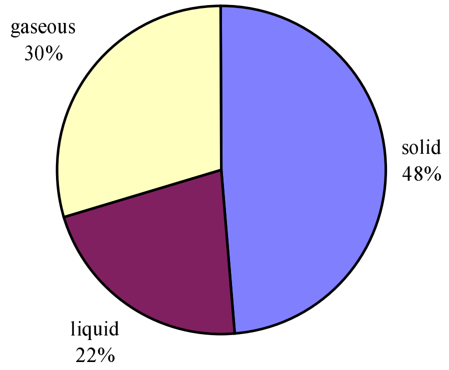
Figure 2.1 Emissions of CO_2 in transition period



Note: The straight line in the figure specifies the adjustment for the CO_2 emissions level under the Kyoto Protocol.

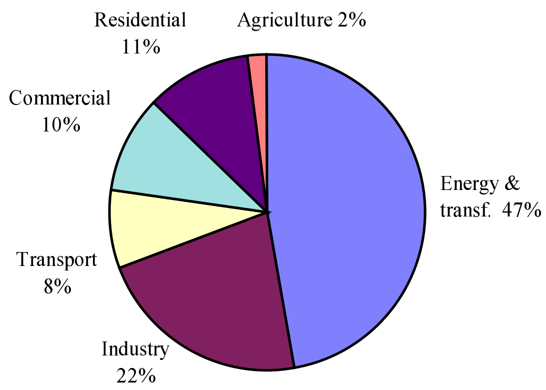
Additional data on the CO_2 inventory for 1996 are listed in APPENDIX 2 of this study. Figure 2.2 presents the 1996 CO_2 emissions data for different fuel types. The contribution from particular industrial sectors is shown in Figure 2.3.

Figure 2.2 CO_2 emissions from fuels in 1996



Source: Emissions data calculated with use of IPCC methodology on the base of Energy Statistics of Ministry of Economy SR;

Figure 2.3 CO_2 emissions from economic sectors in 1996



Source: Emissions data calculated with use of IPCC methodology on the base of Energy Statistics of Ministry of Economy SR.

The energy and transformation, commercial/institutional, and residential sectors all showed substantial relative decreases in emissions for the monitored period. On the other hand, emissions from industry and transport have increased relative to the mean. This structure and trend in emissions led us to examine combustion emissions sources in energy production and transformation, industry, commercial/institutional and residential sectors with respect to emissions projections and abatement costs.

As noted earlier, the Slovak Republic in 1990 enacted environmental protection measures with a secondary impact on GHG (CO_2) mitigation and sinks. Although the Act on Protection of the Air focuses primarily on base pollutants, it represents one of the most important tools for reducing CO_2 emissions. This law established the use of Best Available Technologies Not Entailing Excessive Cost (BATNEEC) for new and retrofitted units as well as air pollution charges for emitters. According to the BATNEEC requirements, new technologies must meet basic emissions standards. The present emissions standards applied in Slovakia for fossil fuel combustion are thus harmonised with the EU standards. The existing facilities must meet these standards within a strictly determined period. In this way, the Act has been a driving force for implementation of new technologies and/or fuel switch processes and a consequent positive impact on CO_2 emissions reduction. This study therefore examined the possible effects of this legislation on SR's primary fuel mix. The results served as input data for emissions scenario modelling and are included in APPENDIX 2.

2.2 Methodological Framework And Input Data

To determine potential CO_2 offset in Slovakia, modelers must design reasonable scenarios of GHG emissions development. As we have already mentioned, energy-related CO_2 emissions play a dominant role in the balance of total GHG emissions in Slovakia and should therefore be the focus of most JI projects. The CO_2 scenarios play an important role and are best used with a sectoral and aggregated modeling approach. Furthermore, an appropriate model will use input data on economic activity and produce projections of final energy uses and energy-related CO_2 emissions. Detailed descriptions of the methodology used for the sectoral and aggregated approach as well as input data values are listed in APPENDIX 2. The following input data were used:

1) Flowsheet of the total energy system
2) Energy balance of the year 1995 (the base year for the study)
3) Annual growth rate of individuals' energy demand stream for the study period (1995–2010)
4) Fuel and energy prices and their escalation
5) Investment costs of renewals/replacements
6) Technical data on individual energy nodes (efficiency or heat rates, capacities and expansion plan of energy conversion units, time of retirement, fuel mix for technological uses, etc.).

Using both the bottom-up and top-down approach for the modelling, we observed a discrepancy in fuel oil consumption: the bottom-up analysis gives us higher values of CO_2 emissions. This discrepancy is due to a certain volume of imported fuel oils which has not been included in the national energy statistics, although individual consumers reported their consumption of these fuel oils in the National Emissions Inventory System (REZZO). The data on this system have been used as the source for the bottom-up analysis and dissaggregation of fuel consumption by individual sectors.

The problems of the energy balance modelling in countries with economies in transition are as follows:

- Historical data cannot be used for the calculation of elasticity factors
- Industrial restructuring has changed fuel mix and energy demands
- The economy is not fully transparent (subsidies, direct or grey, and price regulations)

- The expansion plan of the nuclear electricity supply and the loading order of individual power plants are highly uncertain, complicating the use of internationally accepted models (WASP, INFOM, DECPAC).
- Impact of new environmental legislation
- Uncertainties of future development.

In order to overcome these problems, we applied the following approaches:
- Development of several scenarios that consider not only different activity trajectories but also different elasticity factors
- Bottom-up analysis of energy and carbon flowsheet
- Use of a different expansion plan in the public electricity generation sector
- Bottom-up analysis of the responsibility of individual utilities for the adoption of new emissions standards.

The approach used in the modelling and dissaggregation of individual sectors is described in APPENDIX 2 (part A2 1). The proper design of an energy flowsheet enables us to follow the impact of new emissions standards as well as penetration of new technologies on the demand and supply sides of this network. Table 2.1 lists the main indicators used in the modelling process. APPENDIX 2 discusses the macroeconomic indicators and emissions standards, as well as their impact on the fuel mix, in more detail. The elasticity factor represents the largest uncertainty.

Table 2.1 Indicators for modelling

Sector	*Indicator*	*Elasticity or other factors*	*Emissions standards*	*Fuel mix*
Technology fuel	GDP of industry	Expert estimation	no	Constant
Technology heat & electricity	GDP of industry	Expert estimation	yes	Changed
Steel production	Commodity t of steel/year	Expert estimation	no	Constant
Metallurgy heat & electricity	Commodity t of steel/year	Expert estimation	yes	Changed
Residential fuels & DH	Dwelling, heat, HW, appliances	Expert estimation according to other EIT	no	Changed
Residential electricity	Dwelling comm. area	Expert estimation according to other EIT	-	-
Other (service, comm., agriculture) electricity	GDP	Expert estimation according to other EIT	-	-
Other (service, comm., agriculture) DH & fuel	GDP	Expert estimation according other EIT	yes, sources >5MWt	Changed
Transport	Vehicle fleet	Mileage x consumption	no	On vehicle fleet

DH - District heating, HW - Hot water

2.3 *Macroeconomic Indicators in the SR during Transition to a Market Economy*

Macroeconomic indicators determine the main share of final energy consumption. Appendix 2 describes the approaches and assumptions used to project this value. An analysis of historical data listed in Appendix 2 shows that industry occupies a large share of energy demands in Slovakia and will likely remain significant in the near future. Nevertheless, a projected increase in the share of the service and commercial sectors will influence energy demand levels and the structure of final energy demands. These tendencies indicate that the role of industry will include

- growth in national economy efficiency;
- a decrease in production demands for intermediate consumption;
- growth in export efficiency.

The forecast of the Slovak economic structure for the period 1998–2010 is based upon the following assumptions:

- decreasing share of agriculture and industrial production;
- oscillating share of building (about the level achieved in 1997);
- increasing share of market and non-market services.

Lower external demand and a slow decrease in structural rebuilding would tend to favor lower GDP growth; conversely, higher external demand and increased structural rebuilding based on effective investment allocation would favor a higher rate of growth. Table 2.2 summarizes the forecast for high and low GDP growth scenarios. Sectoral growth projections are summarized in Table 2.3.

Table 2.2 Development of feasible GDP creation in Slovak economy

	1993-1996	*1997-2000*	*2001-2010*
Average annual growth rate in %	6.3	4.4 - 5.7	3.7-5.4

Table 2.3 Sectoral structure of GDP creation (%)
(constant prices December 1995 =100)

Sector	*1995*	*2000*		*2010*	
		Lower level	*Upper level*	*Lower level*	*Upper level*
Agriculture	5.3	4.8	4.6	3.9	3.3
Industry in total	28.7	25.7	23.8	21.7	21.3
Building	4.8	4.2	4.2	3.8	3.7
Services	53.4	56.7	59.9	62.1	66.6
Other	7.8	8.5	7.5	8.5	5.1
Economy in total	100.0	100.0	100.0	100.0	100.0

Disaggregation of GDP data by individual sectors allows us to quantify the GDP annual growth rate (AGR), which, together with elasticity, is required to estimate energy demand. Figures 2.4 and 2.5 summarize the high and low GDP growth rate scenarios for different sectors. Detailed data are available in Appendix 2.

Figure 2.4 Low scenario of GDP growth rate

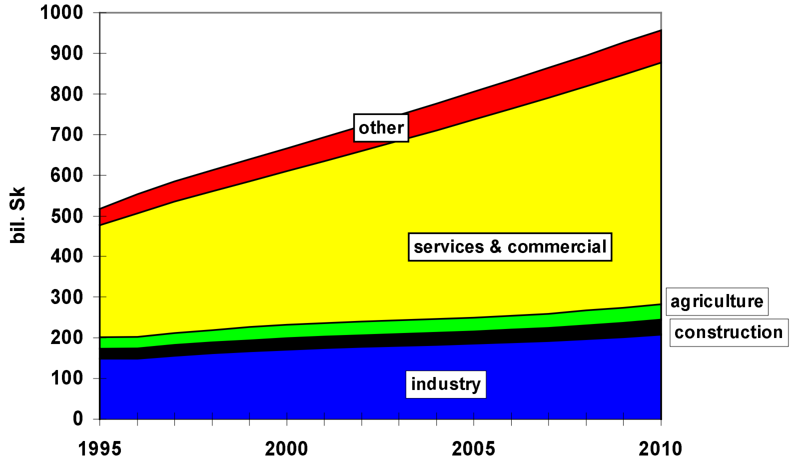
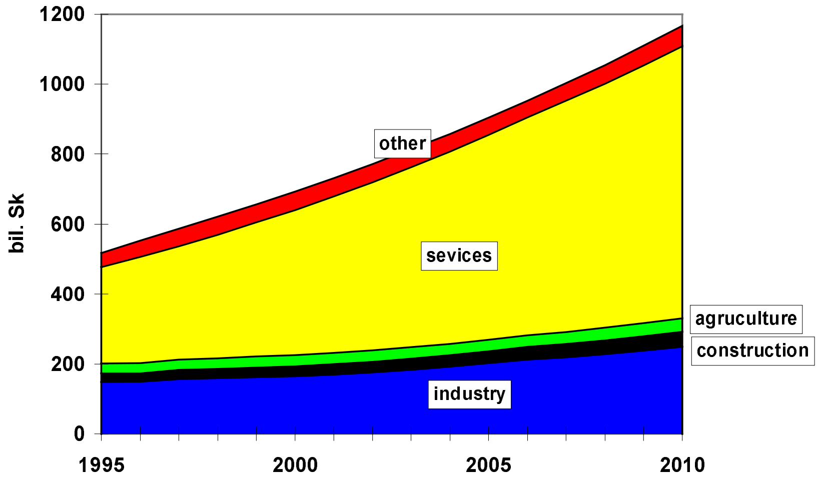


Figure 2.5 High scenario of GDP growth rate



2.4 Baseline Scenario Development

Alternative CO_2 emissions scenarios allow evaluation of model sensitivity to a) different sectoral growth rates; b) energy technology repowering or retrofitting resulting from environmental legislation (emissions standards); and c) the proportion of energy provided by nuclear power. Table 2.4 describes the combinations factors used in the baseline scenarios.

Table 2.4 Applied baseline scenarios

Scenario	*Impact of ES*	*GDP scenario*	*Share of Nuclear energy use*	*Comments*
1	NO	LOW	LOW	Only existing units were considered with the exception of PP in SEa.s. where new nuclear or CC are implemented (high/low nuclear energy use
2	NO	HIGH	LOW	
3	NO	LOW	HIGH	
4	NO	HIGH	HIGH	
5	YES	LOW	LOW	The fuel switch in energy boilers and CC in industry and regional CHP* were adopted in order to comply the new emissions standards
6	YES	HIGH	LOW	
7	YES	LOW	HIGH	
8	YES	HIGH	HIGH	

**CHP - combined heat and power plant*

Given the stable share of individual fuels and the small probability of decreasing technological energy intensity, future electricity demands will significantly affect the CO_2 emission level. Appendix 2, part A2 4 gives a detailed description of the public power plant expansion plan used for our modeling exercises.

Energy carriers representing the final energy demands in the individual sectors are as follows:

- <u>Industry</u> - demands of fuels in technology, electricity and heat
- <u>Residential sector</u> and <u>Non-industrial sector</u> - demands of fuel, electricity, and DH (district heat); supply for heating and warm water preparation; electricity and gas supply for appliances
- <u>Transportation sector</u> - demands of gasoline, diesel fuel, kerosene and electricity

Elasticity and activity indicators are necessary to define adequately the final demands for energy carriers (see Appendix 2, part A2 5).

2.4.1 Results of Baseline Scenarios

Of the eight proposed scenarios, only those scenarios with imposed emissions standards (i.e. scenarios 5 through 8) were considered as a baseline for the assessment of CO_2 mitigation options (Chapter 5). Figure 2.6 provides the results of modeling based on these scenarios.

Figure 2.6 Energy-related CO_2 emissions projections:
Baseline scenarios with an impact on ES

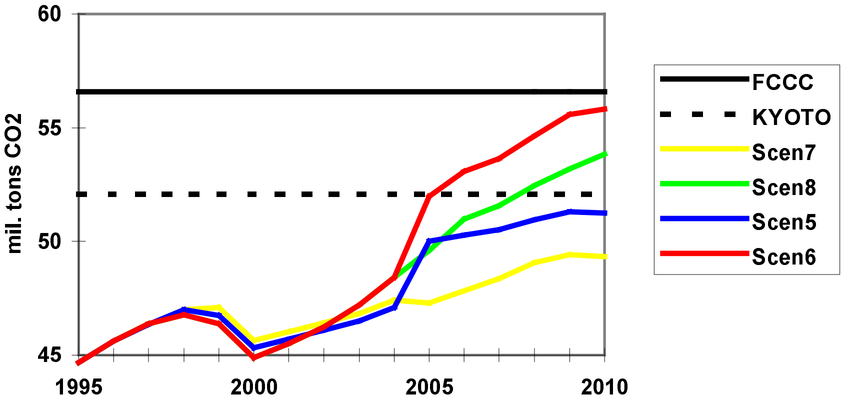


Figure 2.6 suggests that only scenarios with a lower GDP growth rate (scenarios 5 and 7) could satisfy the Kyoto requirements. Scenario 7, which entails a low GDP growth rate, high nuclear energy use, and implementation of measures focused on meeting emissions standards, gives the highest potential CO_2 reduction. The Kyoto reduction commitment shown in Figure 2.6 represent 92% of energy-related CO_2 emissions in the year 1990 only. In this analysis, we believe that activities concerning other GHGs will allow compliance with the Kyoto requirement. Results of other GHG impact analyses are presented in Chapter 5.

The Kyoto reduction commitment applies to the average value of aggregated emissions (calculated as the CO_2 equivalent) for the period 2008–2012. However, the last year of data for our study is 2010, so we used the average value for the period 2008–2010 for comparison with the Kyoto commitments. Table 2.6 gives these average values for the period 2008–2010 for different emissions scenarios, with and without implementation of emissions standards (ES). This Table also displays our calculated value of CO_2 offset potential available for possible emissions trading or JI. This value represents the difference between the Kyoto reduction commitments and the average values achieved in the period 2008–2010 by adopting scenarios 5–7.

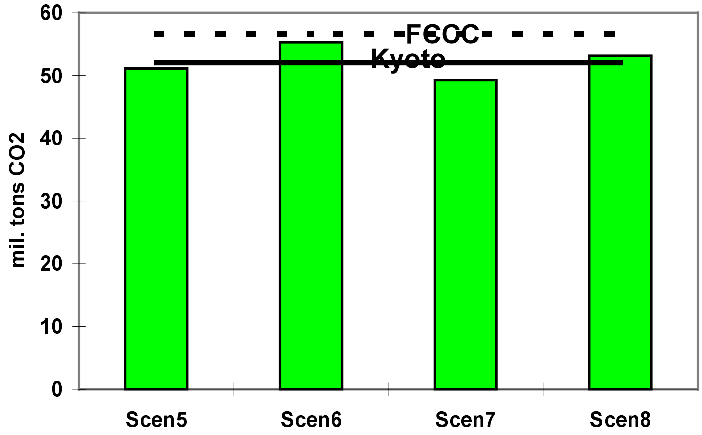
Table 2.6 Baseline scenarios of energy-related CO_2 emissions [kt]
(Average values for period 2008–2010)

		Without	***ES impact***	***With ES***	***impact***	***ES Impact***	***Offset***
GDP	Nuclear energy use	Scenario	CO_2	Scenario	CO_2	□CO2	□CO_2
low	low	1	54097	5	51168	2928	890
high	low	2	57645	6	55350	2295	-3292
low	high	3	51918	7	49274	2644	2784
high	high	4	55265	8	53174	2091	-1116

Source: ES - emissions standards according to the Air Act

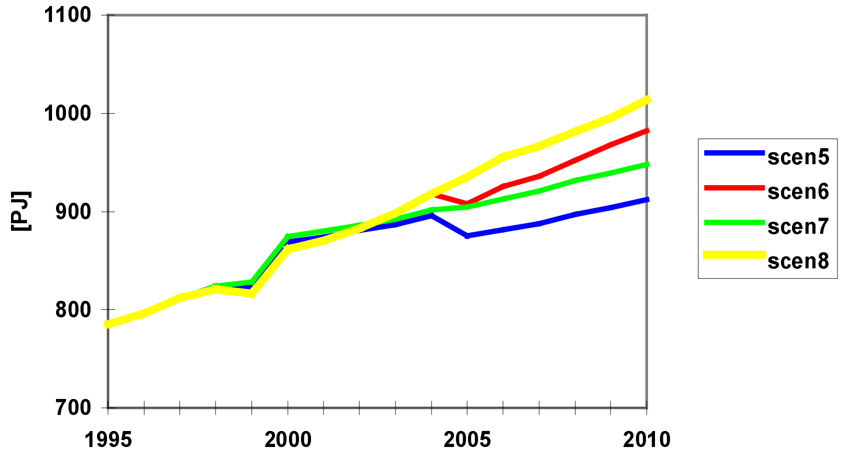
As we have mentioned before, the Kyoto reduction commitments could be achieved under *business as usual* conditions only under scenarios 5 and 7. In the case of scenario 8, only a small amount of additional emissions reduction is needed to meet the Kyoto commitments. Figure 2.7 illustrates these results.

Figure 2.7 Kyoto reduction commitments
and projected emissions under baseline scenarios 5–8.



One indicator of a national economy's CO_2 emissions reduction potential is carbon intensity. This value, as for energy intensity, represents the ratio of CO_2 emissions to the GDP (*e.g.*, tonnes CO_2/mil US$ GDP). The following figures show primary energy source consumption, energy intensity, and carbon intensity over time for scenarios 5–8.

Figure 2.8 Primary energy consumption for emissions scenarios



In addition to final energy demand, the expansion of electricity generation also plays a large role in energy consumption patterns. This is obvious for the period after the year 2000, when the addition of a new nuclear power plant in Mochovce will bring an increase in primary energy consumption; in comparing the scenarios with the same GDP AGR (5/7 and 6/8), scenarios with high nuclear energy use are markedly different in the period 2005–2010. This difference is due mostly to the lower thermal efficiency of the nuclear plant (about 30%) compared to modern combined cycle gas generation (with efficiencies of approximately 50%). Figure 2.9 indicates that the scenario with high nuclear energy use and low GDP growth rate (scenario 7) produces the highest energy intensity, while the low-nuclear, high-GDP-growth scenario (6) gives the lowest energy intensity. The curves of carbon intensity (Figure 2.10), in contrast, show the highest values for scenario 5—which includes a low GDP growth rate and a low share of nuclear energy use. In general, though, Figure 2.10 indicates a broad decrease in carbon intensity during the projected scenarios[1].

Figure 2.9 Energy intensity for emissions scenarios 5–8.

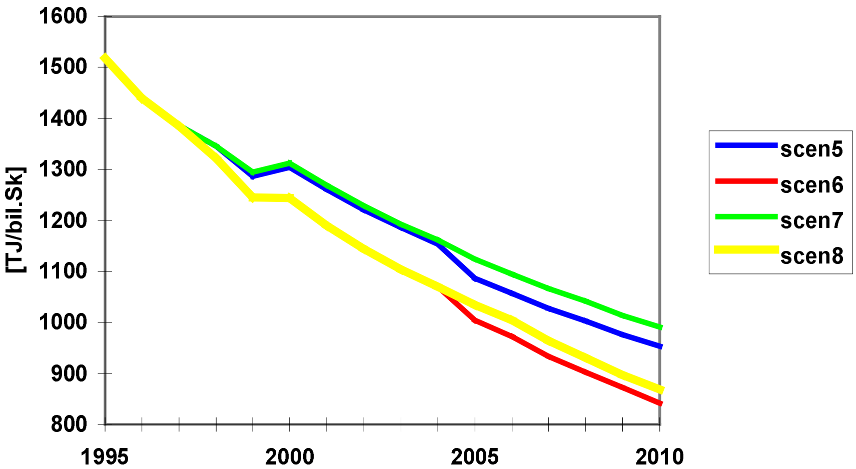
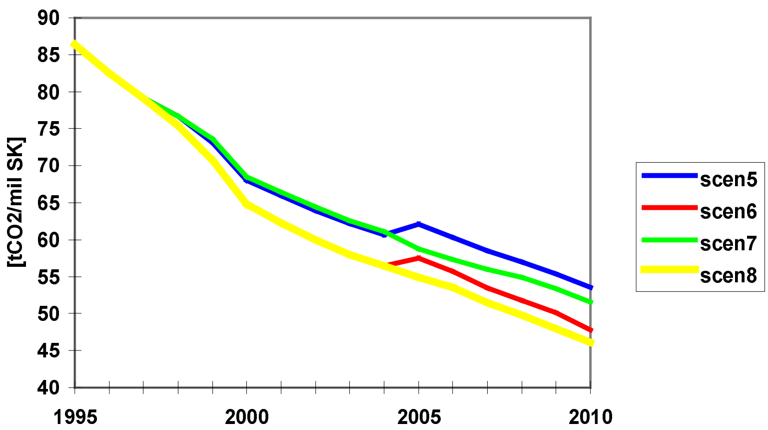


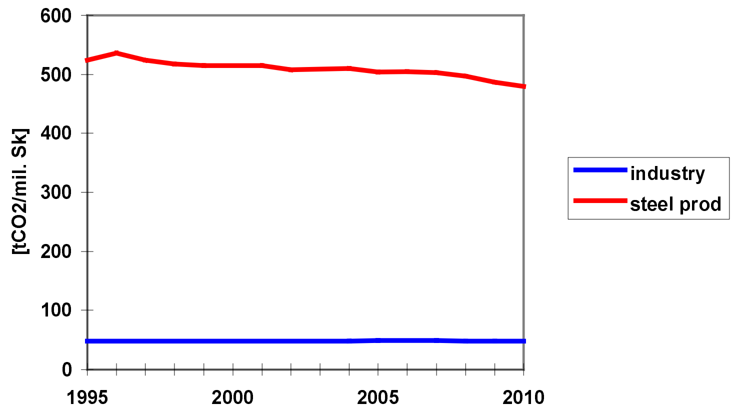
Figure 2.10 Carbon intensity for emissions scenarios 5–8.



[1] The line jump of scenarios 5 and 6 in the year 2005 on figures 2.8 - 2.10 is caused by retirement of 2 units of NPP, which are replaced by combined cycles.

Figure 2.11 illustrates the partititioning of this indicator by sector. Data in Fig. 2.11 indicate that GHG abatement activities should be concentrated in industry and especially steel production.

Figure 2.11 Carbon intensity in industry and steel production



High carbon intensity also results from direct fuel consumption in technology, which means that this sector does not provide much room for mitigation. Only industrial restructuring and an increase in energy efficiency could bring about positive results.

2.4.2 *Results of Baseline Scenarios and Proposals for JI Impact Modelling*

All the scenarios analyzed in previous sections represent *business as usual* options without any measures focused specifically on CO_2 reduction. Under these scenarios, only low GDP growth rates will enable us to satisfy the Kyoto reduction commitments without additional measures to achieve an emissions offset for potential allowance trading or JI. To select a proper baseline scenario for an evaluation of the possible impact of JI, the following facts should be considered:

Scenario 5: A low GDP growth rate scenario allows an emissions offset potential for JI and allowance trading. From a JI perspective, the option with low nuclear energy use requires the construction of combined cycle power generation. However, this action would lead to a higher demand on the import of natural gas. Considering that many projects in the JI pipeline are based on an increased use of NG (fuel switching, cogeneration with CC), this scenario does not offer much room for JI due to the higher dependence on the import of NG[2].

Scenario 6: A high GDP growth rate does not offer any inherent CO_2 offset relative to the Kyoto reduction commitments. At the same time, a low share of nuclear energy use (as in scenario 5) could increase requirements of NG import. This scenario would therefore also not be appropriate for JI impact modeling.

Scenario 7: This scenario offers room for JI projects and emissions trading without further specific activity focused on CO_2 emissions mitigation. However, the combination of a low GDP growth rate and a high share of nuclear energy use seems to be questionable.

Scenario 8: Although compliance with Kyoto reduction commitments is not guaranteed under this scenario, the difference between projected and committed reductions is small and can be overcome through additional measures. This option, with a large investment in nuclear power plants and a high GDP growth rate, is more likely to be implemented than the previous one.

[2] This constraint is due to impact on the foreign trade balance with Russia and an increase in dependency on energy imports from this region.

The input data for modeling were based on expert evaluations and not on historical data. The elasticity and/or autonomous energy efficiency improvement (AEEI) data were chosen from other studies and may contain large uncertainties. We have selected Scenario 8, with a high GDP growth rate and a high share of nuclear energy use, as a baseline to analyze the impact of CO_2 reduction measures and the creation of CO_2 offsets. Nuclear power and final energy demand in industry provide strong possibilities for additional CO_2 mitigation options. Appendix 2 shows the results of a sensitivity analysis of the modeled impact given parameters. These results support the following assumptions for a baseline scenario for JI impact analyses:

- an additional 5% autonomous energy efficiency improvement (AEEI) in the industrial sector, compared with scenario 8 (*business as usual*, a high share of nuclear energy use, a high GDP growth rate);[3]
- exploitation of technical nuclear potential according to the following schedule:
  2000 - 79%
  2005 - 90%
  2010 - 97%

Figure 2.13 displays projected emissions curves for scenario 8 along with the JI baseline.

Figure 2.13 Emissions projections and Kyoto reduction commitments

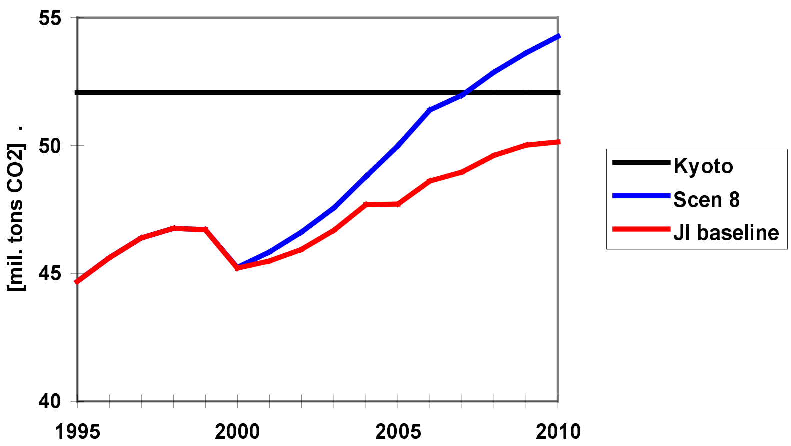


Table 2.7 compares average values of energy-related CO_2 emissions and CO_2 offsets for scenario 8 and a JI scenario.

Table 2.7 Average value of energy-related CO_2 emissions and offsets (commitment period 2008 - 2010)

Scenario	*EM CO_2* [thous. t]	*CO_2 offset* [thous. t]
Scenario 8	53596	-1538
JI concept	49919	2139

[3] Labelling this energy efficiency improvement as autonomous means that improvement is not stimulated by decrease in CO_2 emissions but by improvement of energy efficiency in connection with industrial restructuring.

2.5 *Summary of Emission Projections and Conditions for Emissions Trading*

The presented scenarios of energy-related CO_2 emissions projections are based on the *business as usual* option. The following factors had the most significant impact on modeled emissions levels:

a) Trajectories of macroeconomic indicators
b) Autonomous energy efficiency improvement in the industrial, residential, services, and commercial sectors
c) Acceptance of new environmental legislation focused on air pollutants (other than CO_2) by public, industrial and other energy producers
d) The impact of an electricity generation expansion plan with, preferably, the retirement of old and the implementation of new nuclear units;

Compliance with the Kyoto reduction commitments at a high GDP growth rate will likely require high nuclear energy use, represented by continuing use of installed nuclear power and expansion toward full potential. Together with this, an additional 5% AEEI in the industrial sector must be achieved. Only under these conditions could allowance or credit (JI) trading be considered. The scenarios with a low GDP growth rate can provide for some autonomous CO_2 offset, but options with a high nuclear energy use can hardly be considered. Thus, instead of adding two units at the NPP Mochovce, some CC dedicated to electricity generation only must be installed. This additional gas generation will bring a higher demand for NG import and any room for a mitigation option based on a higher use of NG will be lower.

3 *References*

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14 European Bank for Reconstruction and Development (EBRD): Transition Report 1997, London 1997.
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18 OECD: Economic Outlook 62, December 1992, Paris 1997.
19 Prognos: Energiereport II: Die Energiemärkte in Deutschland im zusammenwachsenden Europa - Perspektiven bis zum Jahr 2020, Basel 1995.
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3 International GHG offset

This chapter describes estimates for potential global GHG offset markets under two conditions: First, that the OECD countries generate demand, and second, that EIT countries generate supply. These regions countries are aggregated into the following four regions. Three regions of Demand include the Pacific Region (PAC), consisting of Japan and Australia; North America (NA) consisting of the USA and Canada; and Western Europe (WE), consisting of the EU plus Switzerland and Norway. The EIT countries constitute the supply region.[4] Trade potentials between the demand and supply regions are analyzed, given the constraints imposed by the Kyoto Protocol. Trade volumes are estimated in real and in financial terms using both OECD demand estimates and EIT supply estimates; furthermore, marginal abatement costs (or willingness to pay or to sell, respectively) are analyzed, although these values proved most difficult to obtain reliably.

The analysis focuses on estimating the potential of GHG market volumes between the defined aggregated regions, and ignores trade within regions and with developing countries.[5] The analysis also does not explicitly model the dynamics of market build up. The trends of market build up will depend heavily on whether allowance trading will soon be practiced along with JI credit trading. If such allowance trading does begin, much more of the potential trade volumes could be realized than if credit trading remained the primary mechanism for transfer. (However, this projection does not imply that GHG reductions would be accelerated to the same degree.) While sectors were disaggregated whenever possible, the analysis was often limited by data availability and reliability—especially for sectoral and aggregate MAC.

[4] Including Ukraine and Russia. Thereby it is not tacitly assumed that Russia and Ukraine will trade only with USA. Therefore, relatively low cost emissions allowances, including possible “hot air”, may be present in the market.

[5] Or between OECD regions.

3.1 System Definition And Delimitation

- ***Regions***: Western Europe (WE), North America (NA), Pacific (PAC), and EIT
- ***Main sectors***: transport, settlement/building, industry, and power generation
- ***Time horizons***: intermediate horizon of 2005, primary horizon of 2010.
- ***Greenhouse gases***: only CO_2, as the leading GHG, is considered

3.2 Post-Kyoto UNFCCC Framework Conditions

The analysis is based on the decisions taken at COP-3 in Kyoto, specifically the reduction commitments agreed to by the various states, the possibility for the parties to enter trading with JI-credits or emissions rights, and the ability to split individual country reductions between domestic measures and JI. Overall, the reduction commitments of most of the demand countries vary between 6% and 8%[6] of the corresponding 1990 emissions. On the supply side, these figures range between 0 and 8% of the respective EIT 1990 emissions. The Slovak commitment is 8% below 1990 level over the period 2008–2012. Chapter 1 of this report provides more complete information on the Kyoto Protocol.

3.3 Data Needs and Availability

The main data needed for the quantitative analysis include:

- Baseline CO_2 and GHG emissions by countries and regions for 1990, 2000, 2010
- Marginal (CO_2) abatement cost (MAC) curves by regions and countries
- Transaction costs

These data sets were compiled from various secondary sources, as explained in the following sections. Sectoral data for MACs have not been available from econometric modeling; however, project-based MAC values have been made available from about five projects in the JI project pipeline. Yet, because these data are based on individual projects with insignificant impact at the national level, they are of limited significance for constructing a national MAC curve.

3.3.1 Baseline CO_2 (GHG) Emissions Data

Table 3.1 summarizes the data collected on country-specific CO_2 baseline emissions data and related reduction commitments based on the Kyoto Protocol and on the EU Conclusion on Climate Change (as agreed by the 1990th Meeting of the EU Ministers of Environment, 3rd March 1997, Brussels). The reduction commitments of the EU countries are based on the proportional transformation of the original internal EU-countries commitments of March 3, 1997 from a total of –15% to –8%. We assume that countries with no reduction commitments do not have to change the emissions targets. The commitments of the individual EU member states do not have any influence on the following market simulations.

6 Neglecting some outliers such as Norway and Australia. In the numerical analysis, the EU is included as a bubble, with 8% reduction commitment (internal variations of commitment levels do not influence the analysis, as Western Europe is treated as one region)

Table 3.1: Country-specific data for CO_2 emissions (1990), baseline projections for 2000, 2010 (and 2020), and the reduction commitments of COP-3 and the EU Council of Ministers 3.3.97

CO2 emissions: baseline 1990-2020 and Kyoto commitments

(anthropogenic EMISSIONS excluding, land use change and forestry)

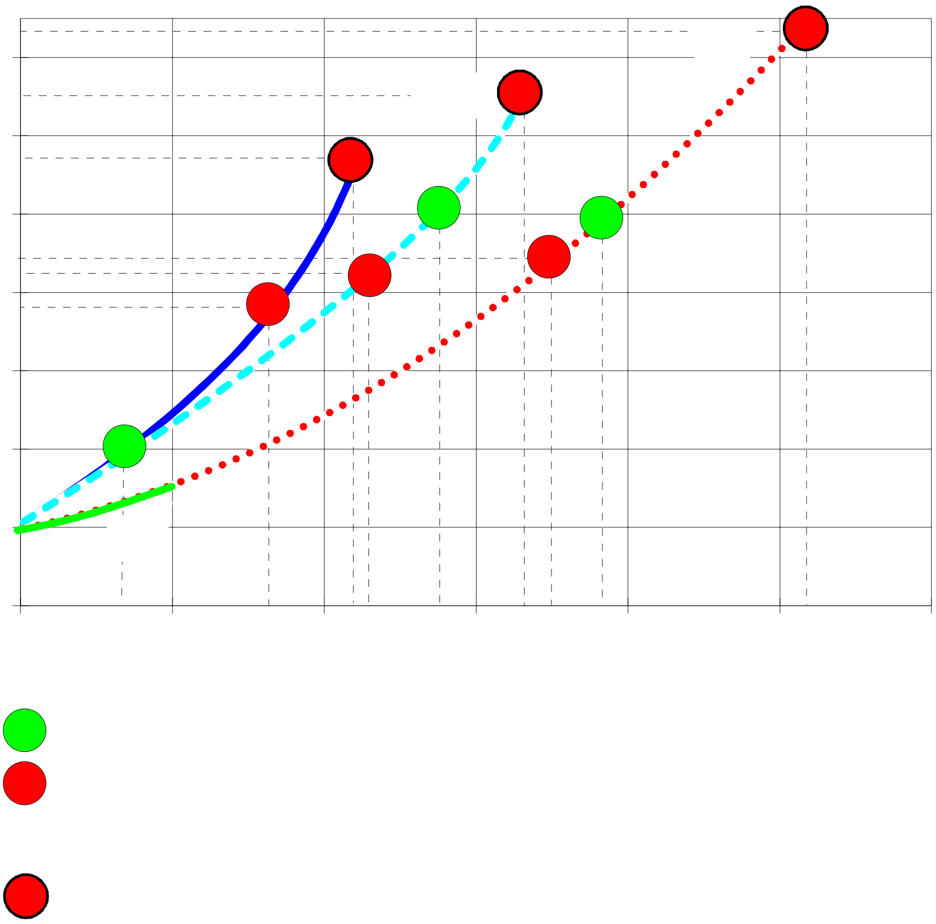
	CO2 baseline emissions				Commitments Kyoto 97				
					Reduction commitments			Reduction	Reduction
	1990	2000	2010	2020			Target 2010	to baseline	domestic
countries/region	mil. t CO2	mil. t CO2	mil. t CO2	mil. t CO2	% 1990	% baseline	mil. t CO2	mil. t CO2	mil. t CO2
ANNEX I	13674	13456	16432		-5%	-21%	13052	-3380	-2366
OECD	10260	10721	12069	13166	-5%	-20%	9710	-2359	-1652
Western Europe	**3370**	**3486**	**3507**	**3764**	**-8%**	**-8%**	**3242**	**-266**	**-186**
Austria	59	66	61	63	-13%	-16%	51	-10	-7
Belgium	113	125	131	142	-5%	-18%	107	-24	-17
Denmark	52	54	52	50	-13%	-13%	45	-7	-5
Finland	54	70	64	65	0%	-15%	54	-10	-7
France	367	398	410	425	0%	-11%	367	-43	-30
Germany	1014	917	854	847	-13%	3%	879	25	17
Greece	82	95	123	148	30%	-13%	107	-16	-11
Iceland	2	2	3	3	10%	-20%	2	-1	0
Ireland	31	37	41	45	15%	-13%	35	-5	-4
Italy	429	482	486	541	-4%	-15%	413	-73	-51
Luxembourg	11	8	10	10	-16%	-5%	10	0	0
Netherlands	168	168	170	170	-5%	-7%	159	-11	-8
Norway	36	40	45	47	1%	-20%	36	-9	-6
Portugal	42	54	62	65	40%	-5%	59	-3	-2
Spain	227	277	291	335	17%	-9%	266	-25	-18
Sweden	61	64	64	81	5%	0%	64	0	0
Switzerland	45	44	46	45	-8%	-9%	41	-4	-3
United Kingdom	577	587	595	682	-5%	-8%	546	-49	-34
North America (NA)	**5420**	**5673**	**6850**	**7628**	**-7%**	**-26%**	**5045**	**-1805**	**-1263**
USA	4957	5163	6300	7000	-7%	-27%	4610	-1690	-1183
Canada	463	510	550	628	-6%	-21%	435	-115	-81
Pacific (PAC)	**1469**	**1562**	**1712**	**1774**	**-3%**	**-17%**	**1423**	**-289**	**-202**
New Zealand	25	30	32	34	0%	-20%	25	-7	-5
Australia	289	333	370	400	8%	-16%	312	-58	-41
Japan	1155	1200	1310	1340	-6%	-17%	1086	-224	-157
EIT	**3414**	**2735**	**4363**		**-2%**	**-23%**	**3342**	**-1021**	**-714**
Bulgaria	83	70			-8%		76	76	53
Czech Republic	166	136			-8%		153	153	107
Estonia	38	20			-8%		35	35	24
Hungary	72	69			-6%		67	67	47
Latvia	23	17			-8%		21	21	15
Poland	415	397			-6%		390	390	273
Romania	171				-8%		157	157	110
Russian Federation	2389	1978			0%		2389	2389	1672
Slovakia	58	49			-8%		54	54	38
Non-ANNEX I	7920	13306							
India	545			2972					
China	1976	3226	4363	6049					
Uzbekistan (1995)		99							
Other Central Asian States (Kazakhstan, Kyrgyz Republic, Tajikistan, Turkmeni-stan)		259							
Others									
TOTAL World	21594	26762	34460						

Sources: IPCC 1996, IPCC 1990, INFRAS 1996, and UNFCCC 1997

3.3.2 *Marginal Abatement Costs (MAC)*

Empirical and theoretical estimates of marginal abatement costs vary widely by source and model simulation. Estimates of MAC generally increase with the percentage level of reduction, and they are high in the industrialized countries, and lower in the EITs, lowest in DCs.
Table 3.2 synthesizes results from different models and from different empirical studies. It gives values for average, high, and low estimates marginal abatement costs (MAC) in different regions and countries. Figure 3.1 shows regional curves that correspond to the data in Table 3.2. For example, Western Europe's 2010 baseline is 4% above 1990 emissions. Note that MACs tend to vary more between countries than between regions.

Figure 3.1: Marginal CO_2 emissions abatement costs for the four Annex 1 regions of interest compared to baseline emissions 2010



Sources: see Table 3.2. EIT countries have the lowest MAC; North America has the highest MAC due to the highest increase of the baseline emissions.

The numbers in Figure 3.1 can be explained as follows, e.g. for Western Europe:
1: The baseline emissions for Western Europe increase by 3% between 1990 and 2010. Furthermore, Kyoto commits Western Europe to an additional 8% cut. Thus, the commitment represents 11% below baseline.
2: Following the model assumptions, from the total of an 11% commitment, 7/10 or about 8% of the emissions should be reduced domestically, while 3% can be fulfilled by offset trade. The MAC of the first tradable tonne of CO_2 is estimated at 29 USD/t

3: If all reduction commitments had to fulfilled by domestic reductions, the MAC of Western Europe would be 48 USD (This value is equal to the highest willingness to pay for offset trade).

Table 3.2: Marginal abatement costs (MAC) of CO_2 emissions with respect to 1990.

	Commitments Kyoto 97				Marginal Abatement Costs			
	Reduction commitments		Target 2010	Reduction baseline	low	medium	high	Main scenario
countries/region	% 1990	% baseline	mil. t CO2	mil. t CO2	$ / t CO2	$ / t CO2	$ / t CO2	$ / t CO2
ANNEX I	-5%	-21%	13052	-3380				
OECD	-5%	-20%	9710	-2359				
Western Europe	-8%	-8%	3242	-266	25 [2]		70 [5]	**48**
Austria	-13%	-16%	51	-10				
Belgium	-5%	-18%	107	-24	31 [1]	80 [4]	100 [3]	**70**
Denmark	-13%	-13%	45	-7	4 [1]			
Finland	0%	-15%	54	-10			40 [3]	
France	0%	-11%	367	-43	0 [1]			
Germany	-13%	3%	879	25	0 [3]		12 [1]	**6**
Greece	30%	-13%	107	-16			179 [1]	**179**
Iceland	10%	-20%	2	-1				
Ireland	15%	-13%	35	-5				
Italy	-4%	-15%	413	-73	170 [3]		331 [1]	**251**
Luxembourg	-16%	-5%	10	0				
Netherlands	-5%	-7%	159	-11	1 [3]	25 [4]	352 [1]	**126**
Norway	1%	-20%	36	-9	95 [3]		>170 [6]	**95**
Portugal	40%	-5%	59	-3				
Spain	17%	-9%	266	-25			1227 [1]	**800**
Sweden	5%	0%	64	0	110 [3]		170 [4]	**140**
Switzerland	-8%	-9%	41	-4	25 [3]		160 [4]	**93**
United Kingdom	-5%	-8%	546	-49		10 [1]		**10**
North America (NA)	-7%	-26%	5045	-1805				**62**
USA	-7%	-27%	4610	-1690	16 [2]		110 [3]	**63**
Canada	-6%	-21%	435	-115		40 [3]	140 [4]	**60**
Pacific (PAC)	-3%	-17%	1423	-289				
New Zealand	0%	-20%	25	-7				
Australia	8%	-16%	312	-58				
Japan	-6%	-17%	1086	-224	41 [2]			**55**
EIT	-2%	-23%	3342	-1021		6 [2]		**6**
Bulgaria	-8%		76			9 [6]		**9**
Czech Republic	-8%		153					
Estonia	-8%		35					
Hungary	-6%		67					
Latvia	-8%		21					
Poland	-6%		390			10 [6]		**10**
Romania	-8%		157					
Russian Federation	0%		2389					
Slovakia	-8%		54					

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2 GREEN (OECD 1994)
3 Jepma 1997a
4 Krom et al. 1996 (ETSAP-study)
5 IEA (Econ 1996/58)
6 Econ 1996/58, corresponding reduction unknown
7 Jepma C. 1997b, in JIQ Vol. 3/4, Dec. 97

The marginal abatement cost data represent a significant source of consternation and uncertainty for projections. Depending on the economic models, MACs can differ widely. Therefore, we compiled the figures from different sources and we qualified them as low, medium and high cost calculations. The last column in Table 3.2 shows the mid-level MACs, which provided the base cost data for the following market simulations.

3.3.3 Transaction Costs

We use the experiences from actual AIJ pilot projects to calculate the incremental costs related to the administration of JI projects. ECON estimated the cost related to feasibility studies, follow-up and evaluation of the project at 5 to 8% of the total project costs. Other estimates range from 10% up to 30% (ECON 1996). The transaction costs will likely be relatively higher during the first few years, and decrease as learning increases efficiency. To simplify the model simulations, we assume transaction costs of 10% of the project costs. The implications of this (and other) assumptions are discussed in section 3.4.

3.4 Options for Market Organisation

3.4.1 Emissions Allowance Trading (AT) and JI Credit Trading (CT)

Ultimately, concrete projects represent the physical basis for any market with GHG reduction products. However, a variety of institutional forms exists to structure and organize this market. The fundamental categories to distinguish between are (1) CO_2 emissions allowance trading (AT) vs. (2) JI-based CO_2 offset credit trading (CT).

Emissions allowances can be traded by individual emitters *ex ante* against the realization of reduction projects. In this system, the full volume of emissions allowances (which is limited by a policy decision) is put on the market by a central, well organized, authorized, and responsible trading agency. The most critical aspect of establishing an allowance trading system is the initial allocation of emissions rights, because of its far-reaching implications for the distribution of wealth. For example, existing emitters are heavily privileged under any kind of grandfathering principle.

Contrary to this difficulty, offset credit trading (CT) can only take place on the basis of (and *ex post* to) concrete CO_2[7]-emissions reduction projects. The claimed or actual[8] emissions reduction of these projects must have been verified and certified by officially authorized procedures. In this case, the market volume of tradable credits builds up only slowly over time, in accordance with the volume of projects certified. An overview of the differences between AT and CT is given in Chapter 2 of this report.

JI is clearly amenable to credit trading, as it does not require national/international agreements for allowance trading schemes. Also, even within CT schemes, clearing-house or market facilitating institutions which buy and sell credits from many individual projects—and which thereby manage a whole portfolio of projects—can play a useful role in lower transaction costs and risks for the individual market player (such as a firm or government). The World Bank, for example, has taken such an initiative with the its “Prototype Carbon Fund” under the Global Carbon Initiative.

While this report focuses on JI-related CT, an AT scheme[9] could in principle coexist with CT. Furthermore, CT could be a learning and “buy-in” phase into a future AT scheme. This approach is logical because the establishment of a full allowance trading scheme on an international level is, both practically and politically, much more difficult. This is because an AT presents a number

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[7] Or - more generally - GHG.

[8] In principle, not only verified, actual reductions can be traded as credits, but also intermediary products such as preliminary or detailed projects, accepted projects etc. Intermediary products with higher uncertainties - such as preliminary projects - will catch lower market prices because of the higher risks involved.

[9] With a subset of Annex 1 countries participating.

of specific methodological, such as compliance and sanction mechanisms, banking, and borrowing. On the other hand, project based JI-credit trading can be started at small scale and expand gradually. Once the JI market is amenable to broad application, AT could be superimposed on CT. Eventually, AT could even supersede CT as the primary method for emissions transfer.

3.4.2 Prerequisite: Compliance and Sanction Mechanisms

Compliance and sanction mechanisms are a prerequisite for the successful implementation of both allowance trading and credit trading. An individual firm (or national government) in an OECD investor country must have an incentive to invest in JI projects in a host country. By the rationale of the JI concept, that incentive is that making this investment will be cheaper than reducing the same amount of GHG domestically. Nevertheless, it must be clear that the do-nothing alternative would be associated with sanctions (such as national CO_2 taxes or equivalent measures) that are more costly than meeting obligations with JI investments.

3.4.3 Typology of Design Parameters

Any system of AT or CT must be defined in terms of key design parameters, structured within a hierarchy of variables at the international and national level:

3.4.3.1 Hierarchy Of Commitments

1) ***International***: UNFCCC COP (such as Kyoto) negotiates and decides on
   a) Global reduction targets (2008–2012) compared to 1990 and/or baseline perspective.
   b) National commitments contributing to the global target or criteria, rules for such commitments, and possibly country-specific differentiation of such commitments (Paterson, Grubb 1996, UNFCCC 1997).

2) ***National***: Each country defines its way to fulfill its commitment by measures such as:
   a) A GHG tax system
   b) A domestic allowance trading system: Government allocates or auctions (part of) the emissions permits.
   c) Government programs
   d) Applying (and enforcing) emissions standards

A set of sanctions must exist and be applied in every system: Instruments (a) and (b) above, together with related enforcement measures, are examples of such market-based implementation systems. In the AT option, sanctions must be available and enforced for cases where actual emissions remain higher than acquired allowances. If these allowances are traded at the fuel purchase (input) level, the prices for the allowances will rise (or fall) until demand and supply of allowances balance. The dynamics of this process are, however, little known, and prices may react very sensitively to changes in the quantity of emissions allowances issued.

Such a hierarchical scheme of commitments must be defined for any GHG-JI/AIJ or AT-trade option. For example, which parties are eligible for trading (governments, sectors, or individual firms) must be clarified. The crediting scheme rules then specify *inter alia* which parts of a party's commitment (government or firm) can be traded and which must be fulfilled domestically.

3.4.3.2 Macro Scenario Design Parameters

At the macro level, the market scenario can be defined by the following set of design parameters:

(1) Commitments
The related country-specific commitments according to COP-3 are detailed in the Kyoto Protocol.[10]

(2) Forms of trading allowed
Basically, COP-3 allowed JI credit trading among Annex 1 countries. The CDM, however, provides flexibility for the voluntary participation of developing countries as well. The following list shows an overview of some different possibilities.
1. AIJ/JI, offsets crediting (only project level)
2. Credit trading under the CDM mechanism
3. Trading Carbon Emissions Entitlements (TCEE)[11]

(3) Geographic extension of trading
1. only OECD
2. only Annex 1 (i.e. OECD and EIT countries)
3. global (UNFCCC), including Non-annex 1 countries through CDM.

(4) Trading parties
1. individual corporations (not foreseen in the Kyoto protocol)
2. governments

(5) Crediting rules and restrictions
1. no restrictions, full crediting of offsets
2. limited restrictions, only a specified percentage of obligations is tradable (e.g. 30%, as assumed in this report)
3. no crediting of offsets (No longer relevant after Kyoto)

(6) Enforcement instruments
- CO_2 or energy tax: uniform international or national; individual
- Domestic rules for target allocation and national trading scheme.

Tables 3.3 and 3.4 show a typological framework for the major institutional, organizational design parameters at the macro and micro levels.

[10] The timing of actual GHG abatement activities over the relevant period 2000 to 2012 is a market parameter, which is influenced by UNFCCC rules on whether CDM and/or JI offsets before 2008 can be counted (banked) for the commitment period 2008/2012.

[11] TCEE or EAT (Emissions Allowance Trading)

Table 3.3: Micro design parameters: actors involved and responsibilities

Actors involved	***Responsibilities / competencies / activities***							
	(1) Identity invest-ment oppor-tunities	(2) Establish baseline	(3) Calculate project cost MAC and volume of offset	(4) Arrange for offset deal	(5) Certifica-tion of (3): Size of offset	(6) Sales of offset	(7) Verifi-cation of offset	(8) .....
Countries, governments: • Investor Countries (WWE, NA, PAC) • Host Countries (EITs) • Non-annex 1 Countries								
Companies from: • Investor Countries (WE, NA, PAC) • Host Countries (EIT) • Non-annex 1 Countries								
Intermediary (broker, fund)								
Verifier								
Monitor								

Table 3.4: Institutional/organizational set up

Scenario class I: strong commitments[12]			
	(1)	(2)	(3)
Scenario	***Geographic extent***	***Credit trading participants***	***Crediting rules***
A1 Main scenario	Annex 1	governments only	30% crediting from reduction to baseline
A2	Europe (WE+EIT)		
A3	UNFCCC		
B1	Annex 1	companies and governments	30% crediting from reduction to baseline
B2	Europe (WE+EIT)		
B2	UNFCCC		
C1	Annex 1		full crediting

3.4.3.3 Actor Related Scenario Design Parameters At JI-Project Level

Table 3.3 shows the relevant micro-level parameters for JI (See also Arquit-Niederberger 1997), in contrast to the macro-parameters listed under 3.4.3.2 above. The table shows the details about which actors may have which responsibility at an individual AIJ/JI project level. These parameters are relevant for JI only (not for AT).

3.4.4 Possible Market Scenarios

By combining the design parameters described under section 3.4.3.2 and 3.4.3.3, different market organization scenarios can be developed. Table 3.4 gives a typological overview of the main relevant scenarios. Due to the relative openness of many parts of the Kyoto protocol, all A-scenarios shown in Table 3.4 should be possible. Scenarios B and C, which include the direct participation of private legal entities (firms), are not covered under the Kyoto protocol. In the numerical analysis, we focus on scenario A1, and specify a 70 to 30% split of the reduction commitments between domestic reduction and JI (or AT) trading (see section 3.4.5).

3.4.5 Institutional and Organizational Structure

a) Main scenario: A1

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12 As outlined above we focus on "strong" commitments.

For the numerical analysis of the offset market potentials and their associated financial flows, we assume a relatively restricted JI regime at the beginning based on scenario A1 with the following restrictions:
- Only Governments of Annex 1 countries participate
- Only 30% of the reduction commitments (OECD) are allowed for JI, with full credit at project level

b) Supra Regional bubble split scenario not considered
The present numerical analysis does not consider a possible split scenario of the JI-cooperation in which two supranational bubble concepts might be created separately. For example, one trading regime negotiated between the USA and Russia/Ukraine was to capture the expected non-restrictive and low cost ("hot air") emissions allowances available in the Russian/Ukrainian commitments. The second bubble in this scenario would be a JI scheme between EU (Western Europe) and the CEECs, including Slovakia.

c) The interests of Slovakia
In order for the Slovak Republic to become a *de facto* host country with a supply of perhaps 0.2 to 1.0 million tons of CO_2 (period 10 years) of project-based credits, an institutional structure must be developed and implemented. The Slovak Government desires a favorable position for negotiation with potential investor countries. To this end, SR should identify a pipeline of economically attractive JI projects, reliably analyzing their probable costs and reduction potential *ex ante*. This series of potential JI projects must then be included in a "shopping list" which can be offered for realization within a framework of one (or more) bilateral governmental agreements with interested investor countries.

Apart from the associated improvements in environmental quality, one of the key motivations to take an early, active role in JI activities is the prospect of attracting significant foreign investments and modern technology and knowledge. This action in turn requires reliable and efficient implementation of the necessary institutional instruments, including

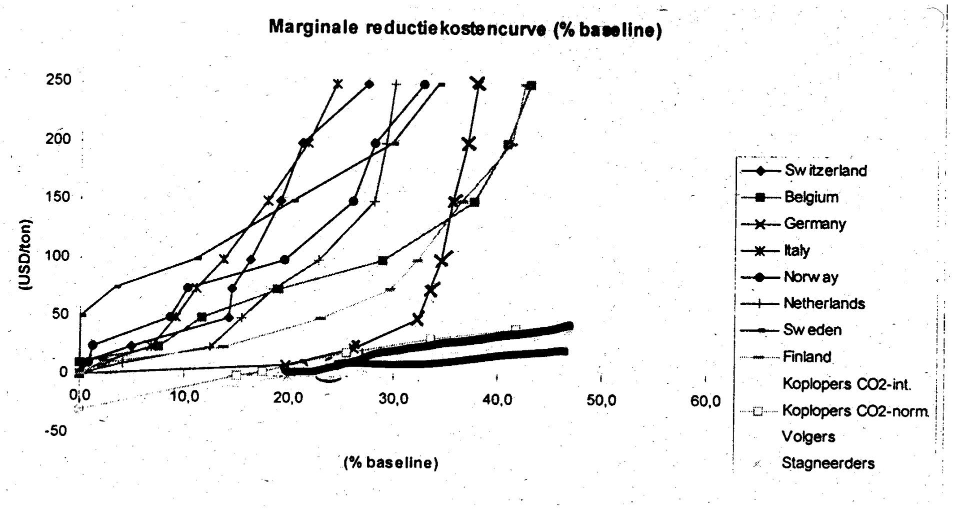
- intergovernmental agreements
- project plan verification and approval
- project-level organizational framework for host-investor cooperation
- project impact monitoring/verification
- information system on project opportunities
- credit award, reporting, and management system
- financial flow schemes (domestic level)
- regulation or guidelines on the establishment of baseline data and for calculating net-cost and reductions at project level
- national level scheme for monitoring/managing national commitment and development of GHG-inventory.

3.5 Monetary Value Of GHG Market Volumes

3.5.1 Methodology: Types of Simulation Model and Estimates For MACs

Figure 3.3 depicts the overall logical framework of quantitative analysis. The potential for GHG offset market volumes is strongly influenced by the difference in MACs between the investing (demand side) countries and the hosting (supply side) countries. Some market volume estimates are already available from earlier studies and simulations with complex economic models such as GREEN and others (OECD, ETSAP, Crash/CEC, ECON, World Bank). However, these models were run for a given set of assumptions and market scenarios which are not known in detail and do not necessarily coincide with the scenarios defined in section 3.4 above. The main differences in the estimated MAC values between the different models stem from different aggregation levels and assumptions about the economy of the energy system, the technological development and about the in- or exclusion of the residential and transport sector (see e.g. IPCC Second Assessment Report 1997). As it turns out, the MAC values from different sources vary widely, especially on the demand side (*i.e.* in the OECD countries; see Figure 3.2). While simulations with the GREEN model suggest MAC values in OECD countries between 15 and 30 USD per tonne of CO_2 reduced—even at reduction levels of 15–20% (relative to baselines)—many other empirical studies find MAC values which exceed 100 USD/t even at relatively modest reduction levels (*e.g.* Jepma 1996).

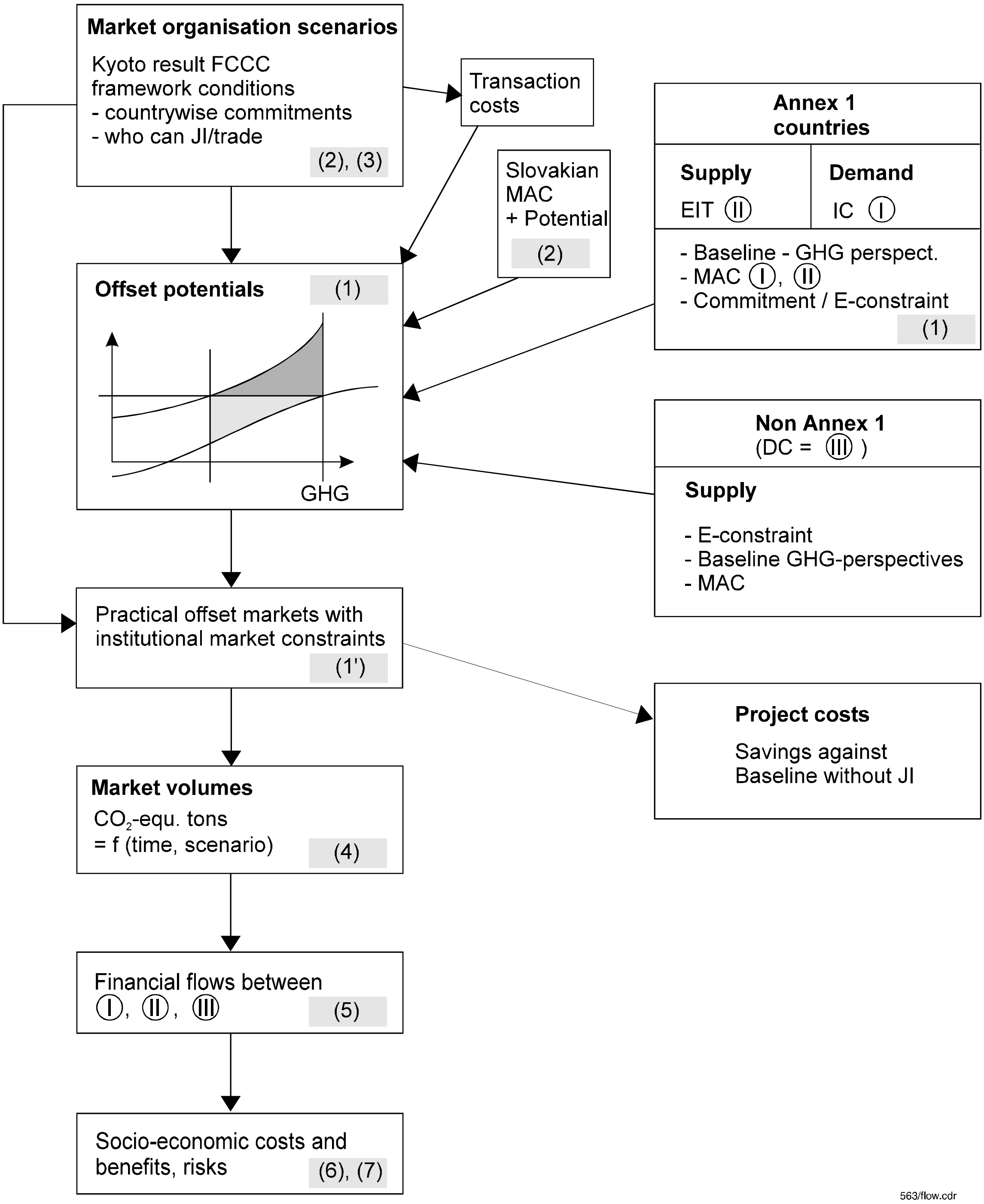
Figure 3.2: Typical empirical results for MACs in different countries



Source: Jepma 1997b

Because of this large variation in MAC values, INFRAS has begun developing a simplified economic model for estimating the potentials of GHG offset trade volumes, of related monetary values of buyers' and sellers' rents, and of traded volumes and financial flows among each of the four regions considered (see Appendix 3). The results of this analysis are presented in section 3.5.2.

Figure 3.3: Logical framework of analysis.



3.5.2 Results of Potential for Credit Market Analyses

Using the data from Tables 3.1 and 3.2, the model estimates the potential demand of individual regions discussed in the previous chapter. The analysis assumes that OECD countries must fulfill 70% of their reductions (relative to the baseline) committed domestically, and only 30% can be JI-traded. These results are presented in Table 3.5; a more detailed description of the modeling approach used, and Appendix 3 gives a comparison of these results with other studies.

Table 3.5: Demand for credit trading estimation [Mt]

	PAC	*NA*	*WE*	*OECD*	*EIT*
2010 level	***1712***	***6850***	***3507***	***12069***	***4370***
Increase to 1990 level	***17%***	***26%***	***4%***	***18%***	***28%***
1990 baseline level	***1469***	***5420***	***3370***	***10260***	***3410***
Target in 2010	***1425***	***5041***	***3100***	***9566***	***3342***
Needed reduction from the 1990 level	***3%***	***7%***	***8%***	***7%***	***2%***
Reduction to 2010 baseline (100%)	***287***	***1809***	***407***	***2503***	***1028***
Reduction domestic 70% of reduction to 2010 baseline	***201***	***1267***	***285***	***1753***	
Reduction by JI 30% of reduction related to 2010 baseline	***86***	***543***	***122***	***751***	
MAC [USD/tCO_2]					
last tonne domestic reduction (total reduction without trading)	***55***	***62***	***48***	***55***	***6***
first tonne JI-Trading	***33***	***37***	***29***	***33***	

3.5.3 Dynamics of Market Build Up

The results of equilibrium analysis modeling from the previous section represents the ***maximum*** potential trade volume under the assumption that all economical offsets will be traded. In this section, we look at the JI implementation in Slovakia only, which contributes about 2% of the total EIT CO_2 emissions.

A reduction of 0.5 million tons of CO_2 corresponds to about 7% of the Slovakian baseline 2010 projection. This level would correspond to about 25 million tons per year of trade in all the EIT countries, at a value of some 500 million USD/a. This figure illustrates that the full OECD demand of 751 Mt/a corresponds to respectable 18% percentage reduction against the EIT 2010 baseline of 4370 Mt.

A JI project-based CT scheme takes significant time to bring certifiable projects and offsets to the market, because each offset bundle requires a separately planned and implemented project.[13] The

[13] As a variation of the market scheme it is possibly - in principle - that intermediary products such as projects or offsets (not yet registered) could be traded earlier than certified credits. They would, however, involve higher risks.

speed of this implementation is constrained by various social, economic, technological, human-resource, and administrative bureaucratic factors. An estimated four person-years of technically skilled labor input must be available for every 10,000 t/a of CO_2 credits produced by fuel switching projects in Slovakia.[14] Although EIT countries with comparatively higher MACs could play the role of both a host and an investor country, this possibility is not expected for Slovakia, at least in the context of the CEECs[15].

3.5.4 Sensitivity Analysis

The market restrictions imposed by UNFCCC (*e.g.*, 30% of the reduction *compared to baseline* is tradable) influence most significantly the magnitude of offset market. Uncertainties in MACs and transaction costs are also a crucial factor, as they affect risks that investors and host will be willing to take when buying or selling JI projects or verified credits. Considering possible uncertainties in all these parameters, factor-of-two (or more) variations of the market value estimated under 3.6.2 are assumed to be possible. These uncertainties are, however, less important for market expansion than various practical constraints such as qualified human resource availability, technology transfer absorption capacity, management of the financial risks involved in a project or in a project portfolio, political support at national level and the corresponding build up of the necessary institutional structure, and so on.

Rough but indicative estimates for the Slovakian situation suggest that in order to reach a trade volume (CT based) of 0.2 Mt CO_2/a within 3 to 5 years, all the administrative and political prerequisites would have to be non-constraining to the development of the JI offset market. This result further presupposes a strong commitment to JI, by both the government and industrial leaders.

3.6 Offsets And Financial Flows

3.6.1 Flows Between Regions of Analysis

The model analysis in section 3.5 (and Appendix 3) also yields estimates for the financial flows from each of the three OECD-Investor regions (PAC, WE, NA) to EIT countries. These flows w result in the potential market volume of between 17 and 22 billion USD/a, with a best guess of approximately 20 billion USD/a.

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14 Provided “high technology” equipment is imported.

15 CEEC: Central and Eastern European Countries

Table 3.6 summarizes these results.

3.6.2 Rents to Host and Investor Countries

Buyers and sellers will share the economic benefits of trading. Assuming an average price of 26 USD per tonne CO_2, the producer rent of EITs would be around 8.5 billion USD/a and the consumer rent of the OECD would be about 17 billion USD (Pacific 2 billion USD/a, Western Europe 1.5 billion USD/a, and North America 13 billion USD/a). (Transaction costs would remove some 2 billion USD from the overall sum.) These rents are relative to a baseline situation without JI and thus represent the benefits over and above the project costs.

Table 3.6: Matrix of potential CO_2 offsets trade for the main scenario (A1) and an average market price of 26 USD/t CO_2.

OECD region	***Financial flow to EIT's Average (bln USD/a)***	***Min.-Max. (bln USD/a)***
Western Europe	3.0	2.7-3.4
North America	14.0	12.4-15.7
Pacific	2.7	2.4-3.0
Total	20	17-22

3.6.3 Sensitivity

Given the many uncertainties mentioned above, the simulations should also estimate the possible variations in the offset market given differences in estimates of MACs and share of tradable reductions. Appendix 3-II gives the detailed results of sensitivity analysis as a function of MACs. The effects of trading restrictions are:

- If no restrictions on trade were imposed, market volume would be about 950 Mt CO_2 trading at about 32 USD/t CO_2. Restrictions reduce the total flow to some 26 USD/t and 744 Mt/a.
- Although the unrestricted offset market rises to a total of 38% of the OECD commitments, the transactions from Western Europe and the Pacific region decrease to 18% respectively 28% because North America is economically interested and able to buy more offsets at higher prices than other demand regions. Thus, an unlimited offset trade system would favor North America and EIT.

The distribution of financial benefits between the different supplier (host) countries depends primarily on the differences in MACs and supply volumes between these countries. For example, assume that Russia—with its large volume of emissions—would have lower MACs than small countries like Slovakia. This situation could push Slovakia and other high-MAC countries out of the offset market almost completely if Russia's supply could meet the entire OECD demand at a lower cost. This type of analysis, however, requires more data about EIT country-specific MACs and an explicit assessment of the corresponding differences in factors influencing transaction costs.

At the level of individual projects, the feasibility of investments is sensitive primarily to assumptions about project cost (investment, O+M), achievable CO_2 reduction, the baseline emissions at the project level, useful project life span, and discount rate. While investment costs will be well known (±15%) at the time of the investment decision, uncertainties in the other factors could change the credit price by a factor of two. This uncertainty will likely encourage near-term risk pooling through insurance or even reinsurance. To illustrate, if the investor has to bear the whole risk regarding the volume of reduction the project will ultimately yield, he will incorporate this risk into his bid and offer a correspondingly lower price for the project. Analogously, if the seller were to have to bear the risks, he will increase the price of sale of the theoretical volume of tonnes reduction credits, considering that in the end, only a part of the expected reduction volume might be verifiable. Thus, the distribution of risks between the investor and the seller is likely to be a crucial institutional and economic issue when market organization principles are defined and adopted.

3.7 *Socio-Economic Costs and Benefits*

3.7.1 *The Situation of Slovakia in the Offset Market*

The following sections detail estimates of the direct economic benefits for Slovakia[16] from JI-credit trading. Assuming a high demand from OECD investor countries for JI offset buys from EIT countries, this study's analysis suggests that Slovakia would benefit from an early start to participating in JI in order to gain experience with the process. On the other hand, holding some credits at the beginning could yield future economic benefits. An optimal and concrete policy, which will depend on the type of risk-sharing schemes adopted, remains to be articulated.

When and at what prices does Slovakia sell early credits that have low MACs? Selling early, low-cost credits near their MAC is inadvisable. Rather, Slovakia should assess the willingness to pay of the OECD countries seeking to buy offsets and seek a market price from these considerations. However, the market price could be hard to predict in advance: one might expect that the "market" price will start relatively high, then fall, and rise again once MACs in EIT countries rise after the cheapest credits have be sold. The monetary benefit to the national economy of the Slovakia is represented by the producer's rent, *i.e.* the difference between this market value of Slovakia's offsets and the project costs. It is up to each national policy how these national benefits shall then be distributed inside the country. For Slovakia, the long-term theoretical potential could be several tens of millions of USD/a)

Slovakia's high percentage of coal[17] (as compared to other fossil or non-fossil energy sources) is an advantage, provided the unit costs of efficiency improvement per unit of MW gained is not higher for coal-based energy processes than for oil or gas. However, importing gas for fuel switching projects could be a macroeconomic disadvantage for the country.[18]

One special strategy proposed by the government is to use the "earnings" from selling Slovakian credits to investor countries for covering the Slovakian costs of meeting is national commitment of reduce emissions under the Kyoto Protocol. This strategy will be more promising if Slovakia pursues a proactive learning strategy as early as possible.

3.7.2 *Local Environmental Benefits*

Local environmental benefits from JI projects represent ancillary positive benefits of climate change policy. Reductions in polluting emissions such as SO_x, NO_x, and particulate aerosols (PM_{10}) are of primary importance for regional public and environmental health. Chapters 2 and 6 describe estimates of the potential of climate change policy for reducing these hazards.

The corresponding benefits could even be expressed in terms of pollution abatement costs (or associated damage costs) for meeting national or local standards. Such costs could either be (partially) deducted from JI project costs or added on the benefit side. Such benefits of reduced air polluting emissions are proportionately higher for JI projects which reduce NO_x, SO_x, and particulate emissions[19] near densely populated urban areas, such as programs in urban areas involving fuel switching from lignite to natural gas. More concrete analysis and conclusions are

[16] the EIT country group, respectively

[17] Coal has higher CO_2 emissions per unit of produced energy than oil or gas.

[18] If data on labour intensity of the relevant technologies could be made available, related impacts on the labour markets in the country could be roughly estimated.

[19] Of course one must consider the differences in emission transmission and transformation phenomena for large and fine particles, and short, medium and long range photo-chemical phenomena related to air pollution phenomena.

only possible if the geographical distribution of projects and CO_2 reductions are known. However, judging from past realizations of multiple benefits from environmental improvement programs, that local environmental benefits could be significant.

3.7.3 Benefits from Technology Transfer

JI projects have a potential for technology transfer from the investor to the host country. The host country can therefore profit from getting direct access to advanced energy conversion and management technology.[20] However, there are some prerequisites for these potential benefits to be realized. The essential condition is that the host country is capable of sustainably absorbing the management of the transferred technology. For example, local institutions and human resources (including technical, managerial, and financial knowledge) must be developed to successful operate, maintain and replace the transferred technology. Bilateral or intergovernmental agreements and private project contracts should include provisions for meeting these prerequisites.

3.7.4 Risk Factors

As mentioned earlier, hosts and/or investors may realize fewer benefits (or meet higher costs) than originally expected during planning. Risk generally increases with increasing time horizons over which the benefits (and O-M-R cost) of an initial investment are expected to accrue (20-30 years lifetime of a power plant; even longer horizons involved in forest management projects). Under such conditions, stability is an important risk control factor at the firm's level.

At the project level, unrealized benefits can result from an overestimation (intentional or inadvertent) of GHG reduction potential or an underestimation of project and/or transaction costs[21]. When selling offsets, project proponents might be inclined to overestimate the expected performance of a project by including, for example, GHG reductions resulting from measures with practically zero net costs. However, since CO_2 emissions can be monitored relatively easily at the fuel input side, uncertainties related to this monitoring parameter are small. In any case, the investor at the project level should ensure that baseline definitions not be altered in the course of the project lifetime. Such modification of project baselines could be considered only if the rules and the maximum scope of modification were clearly specified in advance.

Significant risks can arise at international levels. If new hosts with very large offset supplies (such as India or China) enter the market with attractive offset prices, smaller suppliers might be pushed out of the market and those who bought credits earlier and at higher prices will lose out on the better opportunities.

Clearinghouse, credit brokering, and insurance institutions can reduce individual risk by pooling the risks of a large number of individual projects[22]. The World Bank's proposed Carbon Investment Fund represents one possible manifestation of this concept. At the institutional level, administrative (transaction) costs can be kept at acceptable levels if human resources are well developed and institutions function efficiently.

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[20] Examples are Power Plants, CHP-facilities, heat recuperation technology, automation and control equipment, Heat- and Power-transmission and distribution technology etc.

[21] It can also occur that verification and approval agencies do not fully accept the calculations of the project parties.

[22] It must be realized, however, that the statistical distribution of risks and benefits will be skewed: very few projects will perform better than theoretically planned.

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4. DOMESTIC PREREQUISITES FOR IMPLEMENTATION OF GHG MITIGATION OPTIONS

This chapter provides a brief review of issues related to GHG mitigation options. The main topics analyzed in this part are:

1. *Barriers to implementation of AIJ/JI projects;*
2. *National GHG mitigation strategy and policy;*
3. *Institutional arrangements and capacity building for JI.*

The primary barriers to participation in AIJ/JI projects are identified as:
-Institutional and regulatory barriers;
-Lack of financial resources;
-Non-availability of local technical knowledge related to project implementation;
-Lack of analytical methodologies;
-Lack of clear, unbiased information on AIJ.

The Slovak Republic has not yet adopted an integrated strategy on GHG mitigation. However, many environmental protection measures implemented since 1990 (focused primarily on energy conservation and air protection) have had ancillary benefits of GHG mitigation and sink enhancement.

The following factors are important in designing a proper institutional framework for JI and/or AT:

a) *Existing governmental institutions and non-governmental bodies;*
b) *Existing inventory system and individual institutions' responsibility to the national GHG inventory;*
c) *Availability financial resources;*
d) *Desirability of nimble, flexible, efficient, and responsive institutional arrangement.*

4.1 Introduction

GHG reduction measures must necessarily be designed and implemented within a national framework. Thus, individual projects must be generally consistent with the national economic and energy strategy and also fit more specifically within the investment program of the energy system. As Chapter 1 noted, government policy can significantly influence macroeconomic conditions such as employment, inflation level and budget deficit. Economic trends and the macroeconomic policy form the basis for the local investment climate and heavily influence the path of current and future GHG emissions. Lack of economic stability is a key obstacle to attracting private capital. The economic situation in EIT countries is changing rapidly; the transition process will therefore not be sustainable unless strong institutions emerge to underpin the new market.

Economic reforms create the demand for institutional change, but institutional reform tends to lag political reform. For example, the Slovak Republic has not yet fully developed the legal, regulatory and institutional framework needed to support large private investments (See Fig.1.1 and 1.2 in Chapter 1). One prevalent characteristic of the Slovak economy is the lack of investment sources needed for implementation of new, more efficient technologies. Another negative but related feature is the lag of industrial structure improvement toward less energy-intensive production. On the other hand, as Russia and Ukraine have shown, economic decline may cause GHG emissions to decline too, especially in the case of energy-related CO_2. Such emissions offsets can create room for future emissions trading. However, the large uncertainty in future economic development typical of most EIT countries, leads to a linked uncertainty in GHG emissions projections. Therefore, managing GHG mitigation will require effective incentives and institutions. Capacity building could help us to overcome information and motivation barriers and also create a business climate that would be attractive for foreign investors and facilitate technology transfer.

While allowance trading can be quite easy to control at the national level of the host country, some risks of GHG emissions leakage from the applied project to other sectors of national economy exist. Therefore, properly designed institutional arrangement should prevent or minimize these risks. Furthermore, establishing a special bureaucratic body for managing transaction costs will likely not be productive; using existing institutions in combination with licensed independent consultant groups on a contract basis would be preferred. An effective system of licensing, project verification, and emissions monitoring should help avoid overruns of the national emissions cap. However, before developing this system, the following topic merit careful review:

- Barriers to implement AIJ/JI projects;
- Environmental policy and legislative framework;
- Institutional arrangement and capacity building.

4.2 Barriers to AIJ/JI Projects

Prior to a discussion of the design of investment-friendly incentives to increase the flow of GHG mitigation projects, the barriers to participate in AIJ projects (to the extent that AIJ pilot phase experiences allow) should be analyzed and understood. These barriers fall under the following categories:

- <u>Institutional:</u> Local regulatory capacity of host country to create and manage AIJ projects and interest where local motivation is weak;
- <u>Financial</u>: Availability of financial resources to support the creation of capacity for project management;
- <u>Technical:</u> Specific knowledge on the nuances of AIJ regulation, monitoring and enforcement;
- <u>Analytical</u>: Knowledge of methodological issues and quantification methods that are locally not available;
- <u>Information:</u> Availability of clear, unbiased information on AIJ

The list of incentives for AIJ projects summarized in Table 4.1 can be useful in preparing the rules for JI projects.

Table 4.1: List of Incentives for Host and Investor Countries

Host Country	***Investor Country***
clear simple	procedures
Co-financing of education and capacity buildings	Tax
Support for local NGOs	Tax exemptions
Access to information: technical data	Subsidies
Preferential tariff treatment of imported equipment for AIJ projects	Access to advance information: development bank
Overcoming of financial barriers at new technology transfer	"Banking" GHG reductions for credit in post pilot phase
Secondary effect of AIJ projects on the energy conservation and other emissions abatement	Risk insurance
Access to international co-operation	Non ODA co-financing for research and development
	Preferential tariff treatment on imports of environmentally friendly products

Even though the interests of host and investor countries may differ, for the small volume of CO_2 offsets, the position of host country can easily change into an investor's perspective if it uses improper policy to implement AIJ projects. Therefore, effective and reliable national monitoring systems are needed for both host and investor countries.

4.3 National GHG Mitigation Strategy and Policy

The Slovak Republic has not yet adopted an integrated strategy on GHG mitigation. However, many environmental protection measures implemented since 1990 (focused primarily on energy conservation and air protection) have had ancillary benefits of GHG mitigation and sink enhancement. However, SR should directly address the JI/AIJ and/or AT processes as soon possible, or else other EIT countries could capture the emissions market. This target can be achieved only with use of flexible, investment-friendly design of the institutional and legislative framework. Moreover, simultaneously complying with the Kyoto reduction commitments and adopting emissions trading requires a thoughtful strategy. To this end, an environmental and legislative framework for the Slovak Republic is listed in Appendix 4.

The results of the following research programs and projects form the basis for the preparation of mitigation and adaptation measures:

* National Climate Program of Slovak Republic
* National Program of Greenhouse Gases Monitoring
* National Program to Stabilise and Reduce CO_2 Emission in the Transportation
* US Country Study Program

The measures pertaining exclusively to CO_2 emissions reduction resulting from present environmental legislation and energy conservation measures are summarized below. These measures are presented in detail in the First[4] and Second National Communication on Climate Change[5] as well as in the Country Study of SR[3].

4.3.1 *Emissions Of CO_2: Cross-Sectoral Measures*

Measures fully or partly implemented

Although the Act on Protection of the Air focuses on base air pollutants (*e.g.*, SO_2, NO_x, CO, solid particles), it represents one of the most important existing tools to mitigate CO_2 emissions. This law has established the use of the Best Available Technologies Not Entailing Excessive Cost (BATNEEC) standard for new and retrofitted units, and has imposed air pollution charges on emitters. According to the BATNEEC requirements, new technologies must meet basic emission standards. The present emission standards applied in Slovakia (see Appendix 2) for fossil fuel combustion are thus harmonized with the EU ones. Existing facilities must meet these standards within a strictly determined period. In this way, the Act both reduces air pollution and emissions of CO_2.

In addition, the following existing legislation is relevant to CO_2 emissions mitigation:

⇒ Act No. 309/1991 on the Protection of the Air against Pollutants amended by Act No. 256/95;
⇒ Decree of Slovak Government No. 92/1992 by which the Act No. 309/1991 on the protection of the Air against Pollutants is executed;
⇒ Act No. 134/1992 on the Governmental Administration of the Air Protection amended by later decree;
⇒ Act No. 311/1992 on Charges for Air Pollution;
⇒ Act No. 128/1992 on Governmental Fund for the Environment, Promulgation No. 176/1992 on Conditions for Providing and Use of the Financial Means from Governmental Fund for the Environment of the Slovak Republic;
⇒ Act No. 89/1987 on Production, Distribution and Consumption of Heat;
⇒ Act No. 88/1987 and No. 347/1990 on Energy Inspectorate;
⇒ Act No. 286/1992 on Income Tax amended by later decrees;
⇒ Liberalisation of energy and fuel prices;
⇒ Program Supporting the Economic Activities Resulting in Savings of Energy and Imported Raw Materials;
⇒ Act No. 289/1995 on Value Added Tax;
⇒ Act No. 760/1997 on Energy and on changing Act No.455/1991 on Trade Enterprises as amended integrates the following on going active acts:
  ⇒ Act No. 79 /1957 on production, distribution and consumption of electricity
  ⇒ Act. No. 57/1960 on production, distribution and consumption of fuel gases
  ⇒ Act No. 88/1987 on Energy Inspectorate
  ⇒ Act No. 89/1987 on production, distribution and consumption of heat
  This new act is focused on the behavior of the energy market under new economic conditions.
⇒ Act of Energy Economy has been submitted for approval by government. This act should stimulate activities focused on more economical and efficient energy use by implementing:
  - Programs supporting more economical energy uses
  - Regional energy policy
  - Energy audits
  - Obligatory of heat and electricity cogeneration
  - Energy labelling of appliances
  - Energy standards
  - Education and training programs

Measures considered for the future

The following measures have been proposed as possible directions for SR energy and GHG mitigation policy.

⇒ Energy Saving Fund (ESF). This fund would provide subsidies focused on the support of small and medium energy efficiency investment. The fund would be created with 3.8 million ECU from the means of PHARE, 7.6 million ECU from the EBRD, and domestic funds.

⇒ More effective use of renewable energy potential. Obtaining a higher level of renewable energy implementation could yield further CO_2 emissions decreases.

⇒ National Programme of Convergence Strategy for Energy Policy of Slovak Republic to the energy policy of European Union;

These energy policy measures are not specific to greenhouse gas mitigation, but rather are focused directly on the expansion plan of energy sources in Slovakia, thus indirectly influencing CO_2 emissions. All fully or partly adopted measures for the energy, transportation and industrial sectors, as well as an exhaustive exposition of CO_2 production from these sources, are detailed in the Second National Communication[5].

4.4 Existing Institutional and Commercial Basis

As the Slovak Republic has not yet been engaged in the AIJ pilot phase, up to now only experiences with GEF (Global Environmental Facilities) projects are available for review. Institutional structures for JI projects and/or GHG emissions trading should be designed as modifications to existing domestic institutions, possibly including some which have not yet been engaged in GHG mitigation policy (such as the SR Ministry of the Finance, the SR Ministry of the Foreign Affairs, insurance companies, and consultant offices). For practical implication, any solution must minimize administration and transaction costs.

The proposed framework allows licensed independent (private sector) entities to develop AIJ/JI projects on a contract basis. Licensing would ensure the use of approved methodology for project qualification so that calculations of projected emissions reduction and MACs can be confidently evaluated at the governmental level. The proposed framework reserves reporting, monitoring and project verification for the government, as these activities will directly impact the availability of accurate information on the national emissions inventory and current state of compliance.

4.4.1 State Institutions For JI Project Treatment

This section lists current activities of institutions in Slovakia that could constitute a basis for creating an institutional arrangement on JI project implementation.

<u>The Air Protection Department,</u>
<u>Ministry of the Environment of the Slovak Republic (MoE SR)</u>

- Fully responsible for all activities in connection with GHG mitigation option;
- Currently coordinating preparations for two AIJ projects with Norway.

<u>Slovak Hydrometerological Institute (SHI),</u>
<u>Ministry of the Environment of the Slovak Republic (MoE SR)</u>

- Carries out the National Emissions Inventory (REZZO), which focuses on primary pollutants;
- Responsible for the national GHG inventory according to the IPCC methodology using the data from energy statistics;
- Collecting the data for CORINAIR inventory;
- Developing the new emissions inventory system NEIS in the framework of the PHARE project. This system will unify the data collection needed for the national emissions inventory as well as for emissions taxation on the local level. On the national level, this

new system will provide the GHG inventory using bottom-up data from individual pollutant sources as well as top-down data from energy statistics.

Environmental State Administration Offices,

Ministry of Internal Affairs of the Slovak Republic

- Responsible for managing all environmental issues and emissions charges. The GHG issues are not followed on this level.
- Could serve as primary contacts for companies, providing basic information about AIJ, JI and AT concepts.

Departments of Economy Strategy and Policy; Energy Policy and Regulation; and Environmental Policy,

Ministry of the Economy of the Slovak Republic (MoEC SR)

- Collection of updated energy statistics;
- Energy strategy and policy development.

Slovak Energy Inspectorate - Energy Agency (SEI-EA)

Ministry of Economy of the Slovak Republic

Comprises the Energy Inspectorate, the Energy Agency, the Bratislava Energy Center, and the Energy Institute

- Organizes training courses for energy advisers, focused on the thermal insulation of buildings according to current standards and in agreement with the Program of Energy Saving of the MoEC.
- Establishes Centers to provide all basic information and consultation on energy conservation. All information is available without any charge.
- Disseminates all available information on energy conservation.

Statistical Office of the Slovak Republic

- Collects updated statistical data.

Ministry of the Finance of the Slovak Republic

- Could be engaged on higher level in GHG mitigation options in SR;
- In cooperation with banks and financial institutions, could help design investment-friendly financial rules for contracting.

Ministry of the Foreign Affairs of the Slovak Republic

- Could provide knowledge for international contracts with possible governmental guarantees.

4.4.2 Institutions Of Private Sector For JI Project Treatment

Cooperation with independent private bodies on a contract basis can lower administration and transaction costs. Previous experiences in, for example, preparing the Slovak National Communications on Climate Change and the Country Study of Slovakia have established a network of connections that could be directly engaged in JI project design and implementation. Existing environmental legislation can also be used in this process by encouraging acceptance and licensing of new environmentally friendly technologies. The Promulgation of the Ministry of Environment No. 111/1993, charged individual persons and organizations charged to assess these investments in light of their potential emissions reductions.

As we have already mentioned, the Act of Energy Economy defines the conditions for energy audits. These audits will be obligatory for all organizations working on a government budget or with governmental financial support and for all enterprises asking for governmental energy conservation subsidies. The Energy Agency/Energy Institute administers training courses for energy auditors. The number private entities approved to manage GHG mitigation projects should be limited due to the expected amount of available projects and the seriousness of the problem. We also suggest that the complexity of this issue and the high technical requirements for successful participation argue for this type of restricted licensing. The following private sector representatives would likely show interest in participating in various stages of GHG mitigation projects:

Insurance companies

- Can play an important role, especially in pilot phase, where rules are available and internationally accepted;
- Role especially important in countries with economy in transition to help pool macroeconomic, political, and ownership risks.

Energy and environmental audit companies

- The technical capacity of these institutions has already been used on contract basis during development of National Communications on Climate Change, Country Study Slovakia, etc.;
- Can help improve methodology for project development;
- Should apply for licensing for project development;
- Could also participate in monitoring and project status verification phases.

For the Slovak Republic we must also consider:

- Absence of experience from project development in AIJ pilot phase;
- Weak public information about new GHG mitigation concepts;
- Absence of existing legislative and economic instruments that directly support CO_2 mitigation project implementation.

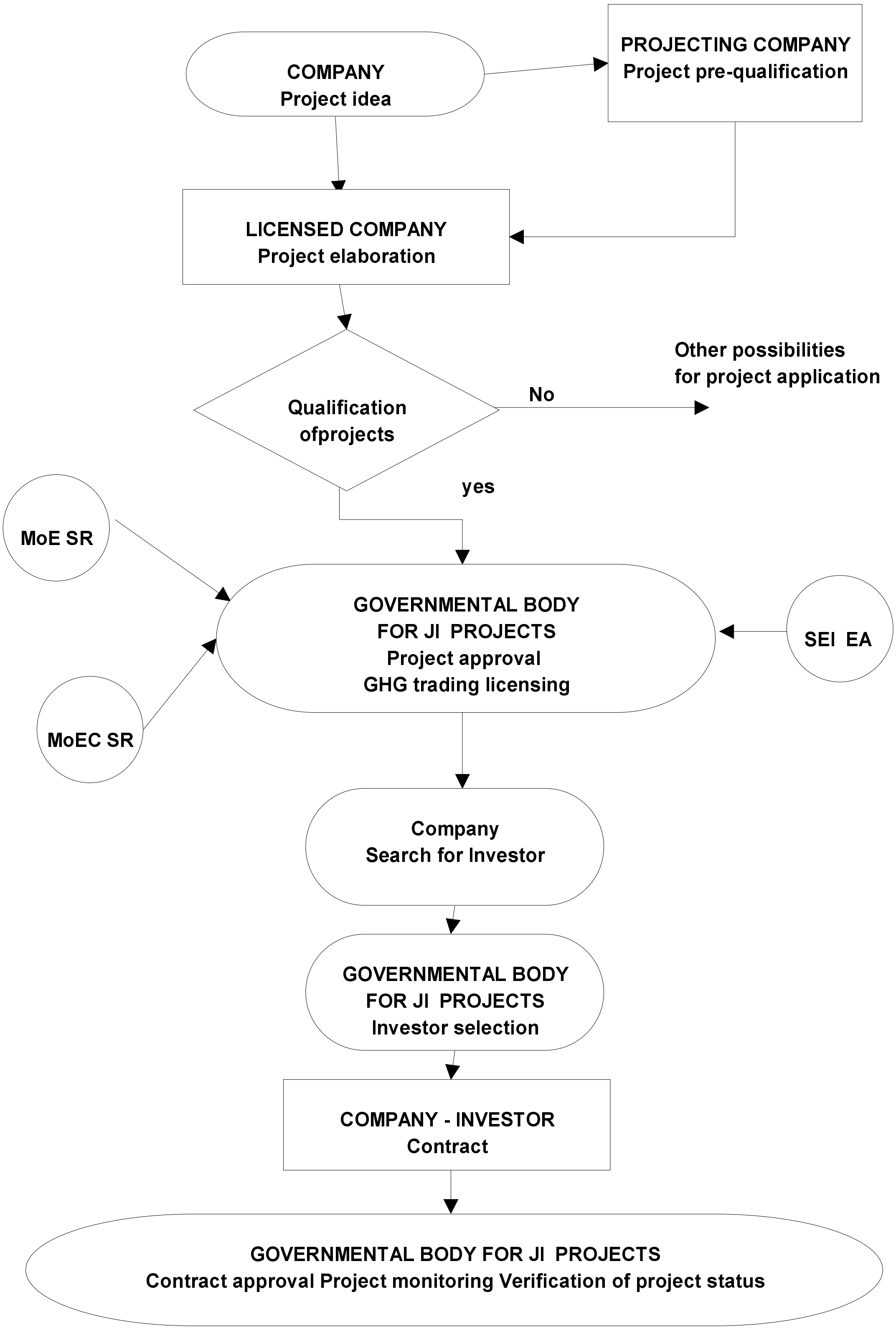
4.5 Design of Institutional Arrangement for JI Projects in SR

The following factors should be considered in designing a proper institutional framework for implementing JI projects in the Slovak Republic:

a) Existing governmental institutions and non-governmental bodies;
b) Existing inventory system and individual institutions' responsibility to the national GHG inventory;
c) Availability financial resources;
d) Desirability of nimble, flexible, efficient, and responsive institutional arrangement.

Having considered these factors, we propose the simplified institutional design for JI project implementation shown in Figure 4.1.

Figure 4.1. Institutional chain for JI project implementation



Main activities of subjects listed in Figure 4.1

1 COMPANY

- Project idea
- Definition of strategy

2 PROJECTING COMPANY

- Pre-feasibility study

<u>3 LICENSED COMPANY (MoE SR and/or MoEC SR)</u>

- Pre-feasibility study
- Pre-qualification of project with respect to GHG mitigation according to approved methodology

<u>4 LICENSED COMPANY</u>

Qualification of project with respect to

- JI Project Category
  - Energy efficiency (supply side)
  - Energy efficiency (demand side)
  - Fuel switching (fossil fuels)
  - Combined cycle
  - Renewable sources
  - CO_2 reductions - sinks
  - Fugitive gas capture
  - Other
- Additionality
- Estimation of MAC*
- Estimation of MAD*
- Project scenario for CO_2 reduction

**MAC = marginal abatement costs; MAD = marginal avoided damage costs; Total costs are minimized at point where the slope of the abatement cost curve equals the negative slope of the damage cost curve/or avoided costs*

5 GOVERNMENTAL BODY FOR GHG MITIGATION PROJECTS

(Representatives of MoE, MoEC, SEI-EA, MOF, MoFA, and/or SHI according to experiences with first AIJ projects)

- Project approval
- Allowance trading licensing
- Credit trading licensing

6 COMPANY

- Project financing
- Direct searching for investor
- Subsidy from national C-funds (environmental charges and governmental contributions)
- Subsidy from international C-funds (GEF, PPC)
- Loans with favorable interest rates, specific mode of payments
- Foreign investor without emissions crediting (AIJ)
- Foreign investor with JI crediting (maybe Prototype Carbon Fund)

- Other available forms (Internet, international stocks, etc.)

7 GOVERNMENTAL BODY
Seeks Investor via
- Own database
- International database of AIJ/JI investors (Internet, CD-ROM, pipelines, etc.)
- International markets and stocks for AIJ/JI investors
- Information campaigns, advertising, etc.

8 COMPANY - INVESTOR

- Monitoring and annual reporting of emissions development

9 GOVERNMENTAL BODY

- Contract approval
- Project monitoring
- Emissions inventory
- Reporting to national inventory
- Ensuring compliance of commitments
- Verification of project status

4.6 Institutional and Legislative Barriers to JI Projects in SR

The proposed institutional framework represents the first specific proposal on the process of initial AIJ/JI project development. As the first two AIJ projects in SR are only in the preparatory stage, the experiences from the implementation phase and contract negotiations are not available at present. Nonetheless, we can recognize the main weaknesses of national capacities to prepare productive infrastructure for transactions.

Table 4.2 identifies some of the impediments to effective JI and proposals for overcoming them.

Table 4.2 Impediments to and remedial actions for JI project development

Impediment type	***Action***	***Responsibility***	***Timeframe***
Information/knowledge	Dissemination of information on costs and benefits of new technologies;	MoE SR,MoEC SR	Permanently
	Dissemination of information on new concepts for GHG mitigation (workshops, information campaigns, round tables, folders, etc.);	MoE SR, Environmental State Administration Offices	Immediately and permanently
	Attracting representatives of Ministry of Financial and Foreign Affairs in problems of GHG mitigation and new concepts of solution on much higher level;	MoE SR, MoEC SR	Immediately
	Regular round tables to disseminate last information on current stage of implementation AIJ/JI projects in SR;	MoE SR, MoEC SR, SEI-EA	Permanently
	Web-site on current status of AIJ/JI projects in SR;	MoE SR, MoEC SR	
Social impacts	Information about new concepts for GHG mitigation (JI, AIJ, AT) can indirectly motivate industry and energy representatives, owners and entrepreneurs to care about technology and environment improvement;	MoE SR, MoEC SR, SEI-EA, Environmental State Administration Offices	Permanently
	Increasing of environmental awareness;	MoE SR, MoEC SR, SEI-EA, Environmental State Administration Offices	Permanently
Financial	Searching and supporting of investments with positive impact on GHG mitigation on the base of existing project pipeline;	MoE SR, MoEC SR, Companies	Permanently
	Preparing of rules to encourage government and companies in GHG mitigation project development;	International expert groups to UNFCCC	Immediately and permanently

5 *The Slovak Republic and the CO_2 offsets market*

The main purpose of the analysis in this chapter was to quantify the emission situation in the SR so that participation in the possible international CO_2 offset market could be evaluated. To this end, we have carried out the following actions:

- Determination of national CO_2 offset potential available for credit and/or allowance trading (AT);
- Determination of abatement costs;
- Evaluation of a suitable schedule for international emissions trading, considering international market conditions and the possible risk of exceeding of the Kyoto commitments;
- Selection of the proper type of measures appropriate for JI and AT;
- Proposal of an approach to the decision making process for JI and/or AT;

The results of analyses following the above mentioned subjects are as follows:

1. The amount of CO_2 offset available for emissions trading could be at a level of 35.6 Mt of CO_2 for the period 2008–2012 or 86.6 Mt CO_2 for the period 2001–2012. These scenarios would represent an income of about 890/2541 mil USD respectively for a 25USD/t CO_2 level of willingness to pay. This offset will be created by the application of special measures dedicated to CO_2 mitigation. The total offset, considering autonomous development, should be achieved at a level of about 39 Mt CO_2 for the period 2008–2012 and 101.6 Mt CO_2 for the period 1991–2012.
2. Abatement costs can change over a large range of values depending on type of measure and sector. Calculations for some measures show negative MAC; nevertheless, considering the financial situation of the SR, these measures will not be implemented without some external help to overcome financial barriers such as lack of investment resources.
3. The time schedule for when emissions trading could come into force will play an important role. An early start to this process, in combination with a reasonable system for sharing emission reduction units (*e.g.*, keeping a safety margin for trading and compliance), will help overcome barriers to the application of GHG mitigation measures. This can lead to mutual benefits for the host and investor countries.
4. All analyses have focused on energy-related CO_2 emissions. Nevertheless, the Kyoto commitments consider aggregated GHG emissions; therefore, projections and measures focused on other GHGs, such as non-energy CO_2, CH_4, and N_2O sources and sinks, should be assessed as well. Data from the Second National Communication on Climate Change in the SR indicate that the level of other GHGs will have decreased by 14% in 2010. The emissions inventory and projections of these gases are connected with higher uncertainties relative to energy-related CO_2. However, saving autonomous offsets for the national inventory can ensure that uncertainties about these other GHGs will not significantly influence the reduction potential created by implementing the mitigation measures.
5. As we have already mentioned, a proper mechanism should be developed for sharing the available CO_2 offset between the national inventory and emissions trading. This sharing will strongly depend on the investor countries' willingness to pay. At a level of 25 USD/t CO_2, about 23% of emissions could be used for emissions trading to satisfy the financial requirements needed to overcome our financial barriers. This estimate reflects a nationally aggregated approach; the real values will be specific to the local contexts of individual projects.
6. The project selection phase should favor projects that combine production of ERUs and financial income from emissions trading within the same entity. So-called *area project types* (preferably increasing demand side energy efficiency in the residential and commercial sector) are better suited to allowance trading than to JI.

5.1 Conditions for Credit and/or Allowance Trading Implementation

Based on analysis of the international GHG offset market (Chapter 3) and requirements to design a proper mechanism, we suggest the following guidelines for domestic implementation:

1. A reasonable GHG reduction strategy should ensure that some share of CO_2 offset remains available for allowance and credit trading.
2. The abatement costs of projects selected for the JI project pipeline must be competitive on the international market.
3. The projects which should be predominantly dedicated to the JI process are those characterized by the use of modern technology and an increasing share in the utilization of renewable energy sources. Preference should be given to projects with appropriate existing capacity or to joint projects with similar types of technology.
4. For allowance trading, *area type projects*, such as projects on energy efficiency improvement in residential sectors, should be used. The recycling of financial incomes from allowance trading to additional such projects is necessary in this case.

As we can see from the analyses discussed in Chapter 2, the emission scenarios are accompanied by some uncertainties. Nevertheless, a baseline scenario of CO_2 emissions has been established for use in modeling emissions trading impacts. This scenario represents the option of high nuclear energy use and high GDP growth rate, with nearly full utilization of technical nuclear potential and an additional increase in AEEI by 5% in industry. Application of this selected scenario can ensure the creation of some offset of CO_2 emissions reduction towards 8% emissions reduction mandated by the Kyoto Protocol. Additional CO_2 mitigation options can create room for credit and/or allowance trading. The types of CO_2 abatement projects appropriate for Slovakia are listed below. Some of these types are presented in the prepared Project Pipeline (see Chapter 6).

A. An increasing share in the use of natural gas in local and district heating systems as well as in industrial boilers;
B. An increasing share in the use of cogeneration units in the industrial sector and sub-sector of district heat supply from local heating plants;
C. An increasing share in biomass use, preferably wood waste in local and district heating systems as well as in industrial boilers;
D. An increasing share in geothermal energy use in district heating systems;
E. Penetration of additional small hydropower plants into the electricity supply market;
F. Demand side management and energy conservation measures;

The first steps in the process of developing a strategy for the SR towards international emissions trading focused on the following critical items:

1) An estimation of the feasible technical potential of JI activities;
2) Determination of CO_2 marginal abatement costs (MACs) for the nationally aggregated level.

Although evaluating environmental impacts in detail is possible for individual projects, this approach is difficult to scale to predict impacts on the national level. This is important especially when an activity in one sector or facility can influence the actual emission of CO_2 in other sectors. A typical example would be activities focused on final energy conservation and implementation of new cogeneration units. Evaluating the *emissions leakage* requires an aggregated approach, can estimate the desired share of special activities on the national level dedicated to some types of JI projects. Furthermore, CO_2 marginal abatement costs on the national level should be different from those on the project side and the determination of MACs on the national level could help decision-makers give preference to individual project types.

5.2 *Description of Methodology*

Evaluating the effects of mitigation implementation on CO_2 offset and abatement costs has two facets:

⇒ Estimation of offset potential and abatement costs for the penetration of selected options into the energy flowsheet. This approach was used as a screening process for the possible penetration rate and average abatement costs to be estimated. In this case, only one mitigation measure penetrates to the energy system and the impact on emissions is not influenced by the other mitigation measures.

⇒ Estimation of the simultaneous impact of selected project types, considering individual penetration rates, estimated by using the previous approach. In this case, the impact of the mitigation measure is influenced by other measures that are simultaneously implemented.

Appendix 5 describes these approaches for estimation of the individual measure penetration rate as well as for the estimation of the abatement potential and MACs.

5.3 *Penetration Rate and Average Abatement Costs of Individual Measures*

Using the methodology described in Appendix 5, the abatement potential and abatement costs have been examined on the assumption that only one type of measure will be implemented. The impacts of individual measures were different in different sectors. The mitigation measures were considered in the public power plant sector (Public PP), regional utilities (Regional CHP), local heating plant for district heat supply (DH local), industrial CHP, commercial/services, and residential sectors. The results are summarized in Table 5.1.

Table 5.1 Review of impacts of individual measures

Measure	*Period*	*Sector*	*CO_2 abatement potential [thousand t]*	*USD/t CO_2*	*Comments*
Fuel switch: NG	2005 - 2010	Regional CHP DH local Industrial Comm&Serv Residential Total	119-594 52 - 259 1212 - 6062 138 - 690 180 - 900 1701 - 8505	6.8 3.5 6.8 4.4 24.5 8.4	Penetration rate 20 - 100%
Fuel switch: wood waste	2005 - 2010	DH local Industrial Comm&Serv Residential Total	101 - 505 1699 - 8494 276 - 1380 350 1748 2425 - 12127	0.5 -2.8 -3.8 -2.8 -2.75	Penetration rate 20 - 100% of coal
Combined cycle	2001 - 2010	DH local & Industrial CHP	369 - 1953	73 to -8.3	Penetration 10 - 30%
Small hydropower	2001 - 2010	Public PP	2635	-12.9	
Geothermal energy	2001 - 2010	Regional CHP DH local	3337	16.4	
Demand-side management	1995 - 2010	Residential heating & hot water	7169- 11848	-14.9 to -15.4	Heat losses decrease 20 - 40%

Note: Average abatement costs in the case of fuel switch option are stable in the whole range of penetration rate (20 - 100%); see Appendix 5.

The main barriers to individual measures can be summarized as follows:

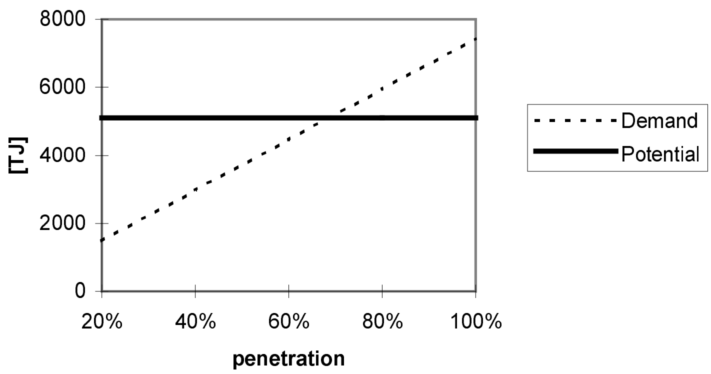
2. ***Penetration of NG into final energy uses*** is possible only with high nuclear energy use. The penetration rate depends upon distribution network enhancement and the possibilities for importing NG. An increase in NG demand without concomitant supply diversification will lead to

a strong dependence on the Russian Federation. Abatement costs will depend on NG price escalation and on the local conditions and investments in the construction of a new distribution grid. To increase abatement costs from 8.4 USD to 10 USD, gas price escalation must only change from 3.44% to 3.67%. The impact of the choice of discount rate (DR) is shown below:

Discount rate [%]	*Abatement costs [USD/tCO_2]*
8	8.8
12	8.4
20	7.4

2. ***Penetration of wood into final energy uses.*** The share of wood penetration is strongly limited by its technical potential. The Energy Policy and Strategy of the SR estimated this potential to be about 5100 TJ. Figure 5.1 illustrates the relationship between additional demands on wood waste and its penetration into the energy flowsheet. As we can see, wood will achieve the estimated maximum potential at a 70% penetration. Nevertheless, considering the uncertainties of this estimate, the penetration of wood will likely not be higher than 40 to 50%.

Figure 5.1 Additional demand on wood and penetration rate



The results of sensitivity analysis indicate that abatement costs are not very sensitive to wood boiler investment costs. A significant increase in the price of wood would be necessary to achieve abatement costs of 10 USD/tCO_2. This situation could result from higher transportation costs in regions with large distances between wood sources and consumers. Therefore, wood prices will be very site-sensitive and penetration rates can be further limited. Our estimation was about 25 - 30%. The impact of the choice of discount rate can be quantified as:

Discount rate [%]	*Abatement costs [USD/tCO_2]*
8	-4.61
12	-2.75
20	-1.05

3. ***Penetration of combined cycle generation*** will be limited by the pricing policies of public utilities. In addition, abatement costs for the aggregated approach are high and will depend on the fuel mix of the electricity replaced in the grid. On the other hand, a combined cycle turbine represents modern technology with high investment costs. Its implementation by adoption of the JI concept will be useful for many independent producers, mostly in the industrial sector. The abatement costs of the project will depend on the share of excess electricity supplied to the grid and the purchase price of this electricity. National policy should stimulate this option in the industrial sector for cases when more than its producer consumes 80% of electricity generated.

4. ***Demand site management and energy conservation measures*** represent activities that should be dedicated to the creation of the allowance trading potential. As stated above, income from allowance trading should be recycled for these options.

5.4 Simultaneous Implementation of Measures

The penetration of individual measures in a simultaneous approach has been studied on the basis of the following screening process:

Table 5.2 Penetration rate of individual measures

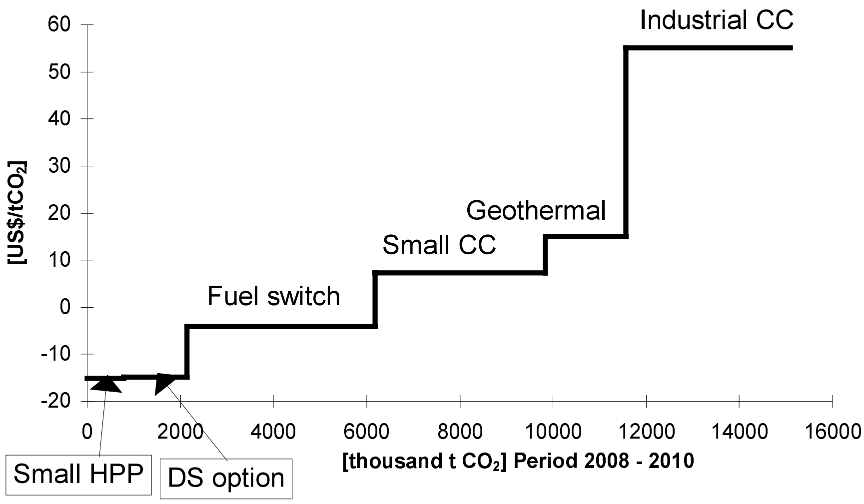
Option	***Penetration rate/ characteristics***
Fuel switch (NG option)	40% of coal is replaced
Fuel switch (Wood option)	60% of available potential 5100TJ in serv&com and residential sector
Combined cycle	10% in Local DH
	20% in industrial CHP
Small hydropower plants	551.6 GWh in 2010
Geothermal energy	7160 TJ in 2010
Demand side measures	3% in 2000 9% in 2005 17% in 2010 30% of heat demand saved by insulation

Using this methodology, the MACs have been calculated for individual measures. These calculations were carried out for the whole selected period (1995–2010). In agreement with the Kyoto Protocol, binding commitments were established for the period 2008–2012. Although the continued absence of international rules preclude a start to the actual credit or allowance market before the year 2008, implementation of new GHG mitigation concepts should begin as soon as possible. Otherwise, other countries could capture market share for the first commitment period (2008–2012). The following Table (5.3) gives the abatement potential of individual measures and their MACs considering the penetration rate and penetration scenario listed in the Table 5.2. Penetration rate influences the MAC of individual options (see Appendix 5), and selected rates in Table 5.2 have been assumed optimal. Figure 5.2 shows estimated cost curves for individual measures.

Table 5.3 Total abatement potential and MACs of individual measures for period 2008–2010.

Measure	***Type of measure***	***AbP_i [thous. t CO_2][23]***	***MAC [USD/tCO_2]***
MIT 1	Industrial CC	3536	55.1
MIT 2	Small CC	3644	7.2
MIT 3	Geothermal energy	1730	15.0
MIT 4	Fuel switch	4040	-4.1
MIT 5	Without small HPP	788	-15.2
MIT 6	Without demand side options	1358	-14.9
Total	***All options implemented***	***15097***	***15.8***

Figure 5.2 Cost curves of individual measures for the period 2008–2010



The estimated MACs were approximately equal to average abatement costs (AACs) (See Table 5.1). Although the abatement costs of projects included in the project pipeline were based on actual fuel prices and additional cost requirements were included in the abatement cost estimate, we can see that calculated costs are not substantially different (see Table 5.4).

Table 5.4 Abatement costs of projects from the JI project pipeline

Sector	*Project type*	*USD/tCO_2*
Local DH	Energy efficiency/fuel switching brown coal to wood waste	2.20
Local DH	Energy efficiency/fuel switching brown coal to natural gas	2.44
Industry	Energy efficiency/fuel switching natural gas to wood waste	-24.74
Local DH	Energy efficiency/fuel switching brown coal to wood waste	31.78

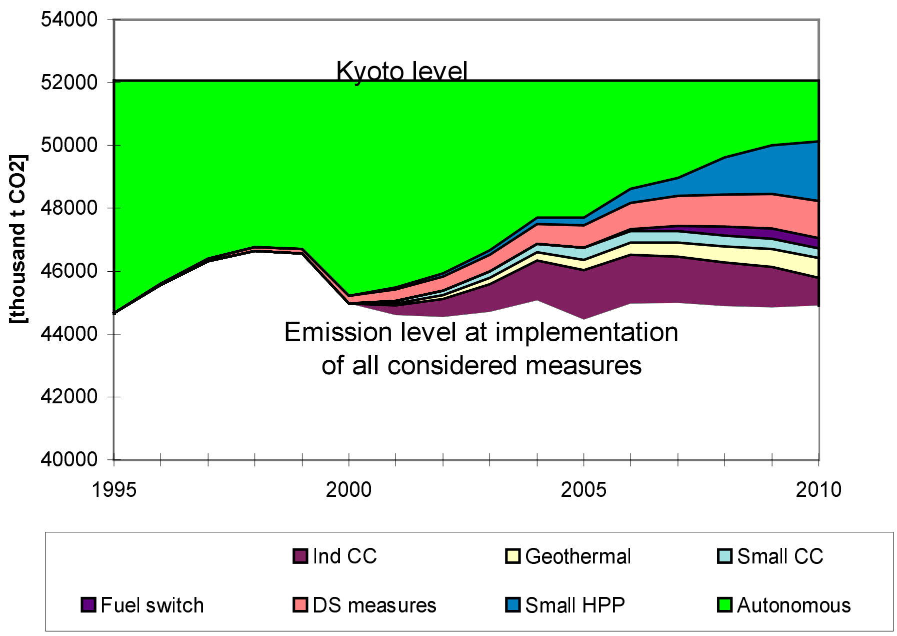
[23]The MAC of fuel switching represents both NG and biomass; in the latter case MAC is negative. Negative values of MAC for options of small HPP implementation and demand side measures are caused by long investment life.

Industry	Energy efficiency/fuel switching heavy fuel oil to natural gas	7.65
Industry	Energy efficiency/fuel switching brown coal to natural gas	2.65
Industry	Energy efficiency/fuel switching brown and hard coal to wood waste and NG	1.40
Local DH	Fuel switch from NG to renewable energy source - geothermal energy	2.73
Energy	Fuel switch from HC to renewable energy source - geothermal energy	4.29

5.5 Time Schedule and Potential for Trading

Figure 5.3 illustrates possible courses and time schedules of penetration of individual CO_2 abatement measures.

Figure 5.3 CO_2 reduction from individual measures



The green area in Figure 5.3 represents the offset created by autonomous development. The areas of abatement impact on individual measures are implemented from the top down, according to increasing MACs. Reduction achieved by autonomous development is followed by the implementation of small-scale hydropower, demand-side measures, fuel switching, small combined cycles, geothermal energy, and finally industrial combined cycles. The bottom border indicates the resulting CO_2 emissions level. The white area illustrates the emissions level for all the measures. Emission reduction units (ERUs) created by the implementation of these measures could thus be traded without negative impacts on the Kyoto requirements. Given the high uncertainties in GHG emissions inventories and projections of mitigation potential, a reasonably designed market strategy should use only a "safe" share of achieved ERUs for trading to minimize possible risks to compliance. For example, some nuclear accidents may result in a lower nuclear energy use. Lack of investment resources may also cause a slow-down in industrial restructuring, decreasing AEEI from the level proposed in our scenario. The lack of investment resources could also block development of some measures with low or even negative MACs (see Appendix 5). Therefore, dividing the available offset into a tradable part and a part used for national emissions inventory compliance is an important task. Several approaches could be used. In our case, we have proposed that credit or allowance sharing must fulfill the following condition:

$$\text{Share} \times \text{Offset} \times \text{WP} = \text{BC}$$

where

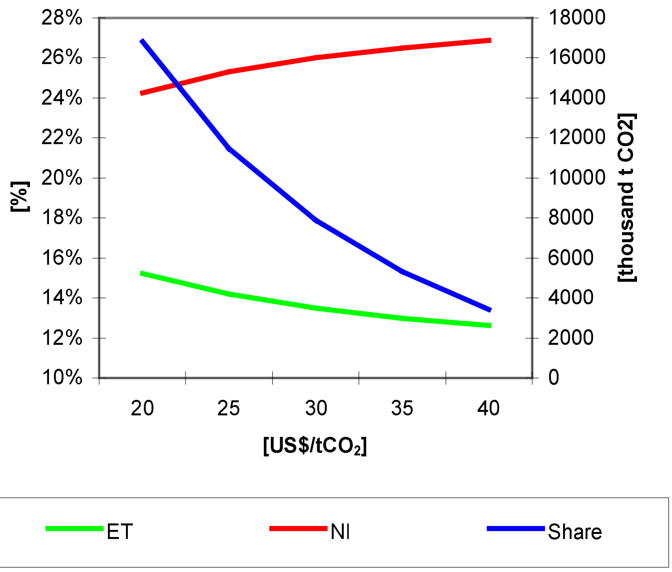
Share	share of the offset from some type of measure used for emissions trading;
Offset	offset created by use of selected type of abatement measure [thousand t/year];
WP	willingness of the investor to pay for an emissions credit or allowance [USD/tCO_2][24];
BC	barrier costs represent the needed financial resources to implement the selected type of measure [thousand USD/year];

The most important factors are the willingness to pay and time schedule of the market's entry into force. The willingness to pay for credits is determined by the MACs of the credit buyer. A detailed description of the characteristics of the international emissions market is outlined in Chapter 3. In the process of selecting the region where our GHG emissions credits and/or allowances could be applied, we must consider the following factors:

* The NA region, especially the USA, will concentrate interests within a large market area, represented mainly by countries such as the Russian Federation and Ukraine. The potential for emissions reduction in these countries is so large and abatement costs for achievement so small that they may able to satisfy the entire NA demand.
* The Pacific region Annex 1 Parties will likely be able to purchase enough offsets from neighboring Asian non-Annex 1 countries to satisfy their demand.
* The West European region thus seems to offer the only possibilities for trading our credits or allowances. The willingness to pay for this region has been calculated in the range of 20 to 40 USD/t CO_2 (See Chapter 3).

Appendix 5 indicates that the lack of financial resources is the primary barrier to abatement measure implementation. By using the methodology described in Appendix 5, the potentially traded volume of emission reduction units (ERUs) has been calculated for different levels of willingness to pay. Figure 5.4 illustrates the results of this analysis.

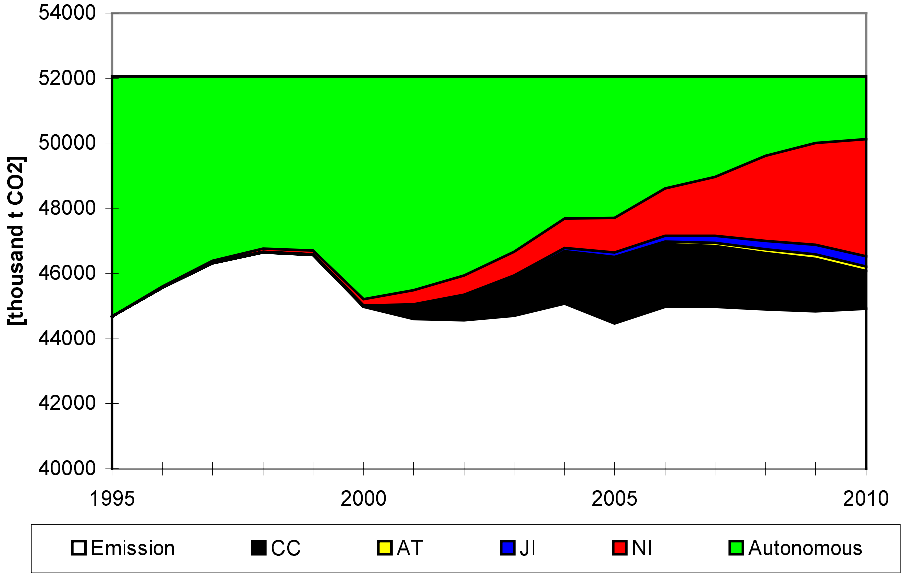
Figure 5.4 ERUs dedicated to the national inventory (NI), emissions trading (ET) and their share of the total offset (Share)



[24] In our analysis, we assume that willingness to pay will be the same or close to the credit market price.

Figure 5.5 presents areas of CO_2 emissions offset created by autonomous development together with emission reduction units (ERUs) divided between JI/AT implementation and the national emissions inventory for different levels of willingness to pay. This figure indicates that for increasing levels of willingness to pay, the volume of ERUs needed for emissions trading (ET-allowance or credit) decreases, allowing a larger share of emissions reduction to be included in the national inventory.

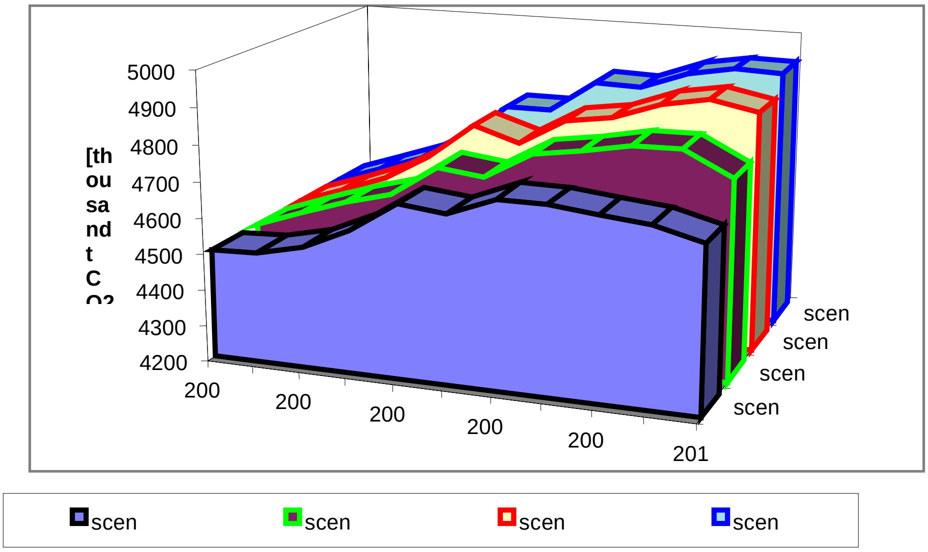
Figure 5.5 Distribution of ERU potential between autonomous development, JI, AT and national inventory



In this figure, the green area represents the ERUs achieved by autonomous development; the yellow (AT) and blue area (JI) represent possible emissions trading. Income from trading will allow implementation of further GHG mitigation measures. The ERUs dedicated to the national emission balance are represented by the red area. The curves in Figure 5.5 show that if without JI or AT, the emission level of Slovakia will trace the bottom border of the green area. After adopting JI and AT concepts by using selected abatement measures, emission levels at the bottom of the yellow area could be achieved. The estimated emission level for the national inventory will trace the bottom border of red area; the yellow and blue areas represent the amount of ERUs transferred to the investing countries according to legally binding rules agreed upon by trading participants. The black area represents the ERUs that could be gained by combined cycle implementation in the industrial and local heating sectors. As we have mentioned before, combined cycle generation has not been evaluated in these analyses; therefore, some additional investigation of this topic would be helpful in the future. These measures should not be excluded from the project pipeline, but clarification of which public utility electricity generation will be replaced by these CC systems will enable better quantification of their impact on CO_2 mitigation.

Slovakia should start emissions trading as soon as possible. Later implementation of emissions trading can lead to a significant slowdown of the CO_2 abatement process, as financial resources could get drawn into larger, more proactive markets. In the following figure, we have illustrated the relationship between the emissions trading time schedule and CO_2 emissions.

Figure 5.6. Impact of emissions trading start time on CO_2 emissions



Scenario	*Start of emissions trading [year]*
Scen a	2001
Scen b	2003
Scen c	2005
Scen d	2007

5.6 *Tradable ERU Potential*

Analyses carried out in the previous section have focused on energy-related CO_2 emissions only. The main reason for favoring these emissions is that energy-related emissions represent the main share of GWP-weighted GHG emissions in SR. Moreover, the inventory and projections of CO_2 emissions are far better quantified than for other GHGs. As we know, the Kyoto commitments cover aggregated all GHG emissions; therefore, the share of emissions required for JI and/or AT should maintain compliance with the *aggregated* GHG commitments required by the Kyoto Protocol. To make a reasonable decision on this question, we have estimated the effects of other GHG emissions on the national inventory and on the volume of CO_2 offsets available for JI and AT[25]. Although this study has focused on other GHG emissions, some data are available from previous projections (the Country Study of Slovakia and the Second National Communication on Climate Change). Table 5.5 summarizes data from the national emissions inventory for the year 1990 and projections for other GHG sources and sinks expressed using Global Warming Potential (GWP).

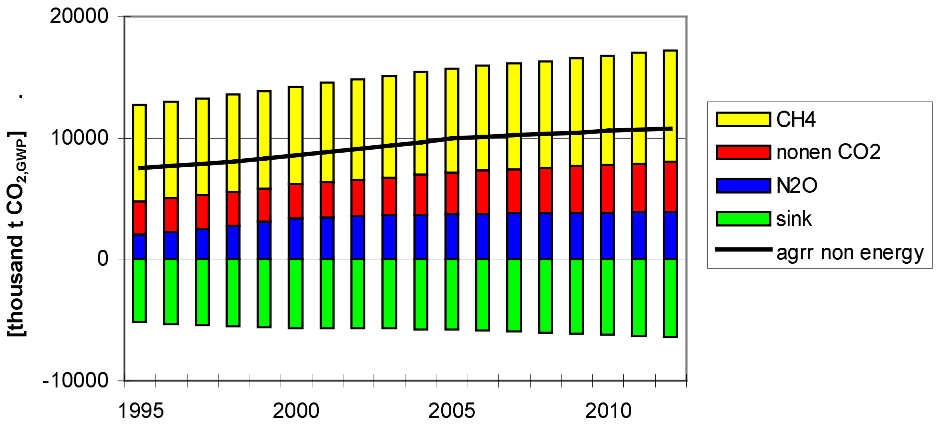
Table 5.5 Inventory and projections of other GHG emissions
[thousand t $CO_{2,GWP}$]

Year	CH_4	N_2O	*Sinks*	*Non-energy CO_2*	*Other GHGs in total*	*% of 1990 level*
1990	9824	3488	4258	3167	12221	100
1995	7882	2048	5198	2769	7501	61
2000	8073	3392	5700	2769	8534	70
2005	8529	3744	5749	3439	9963	82
2010	8987	3840	6208	3930	10549	86

The indicated decrease in other GHGs will be higher (by 8%) than that required by Kyoto commitments. Figure 5.7 gives the structure of other GHG emissions for the period 1995–2012.

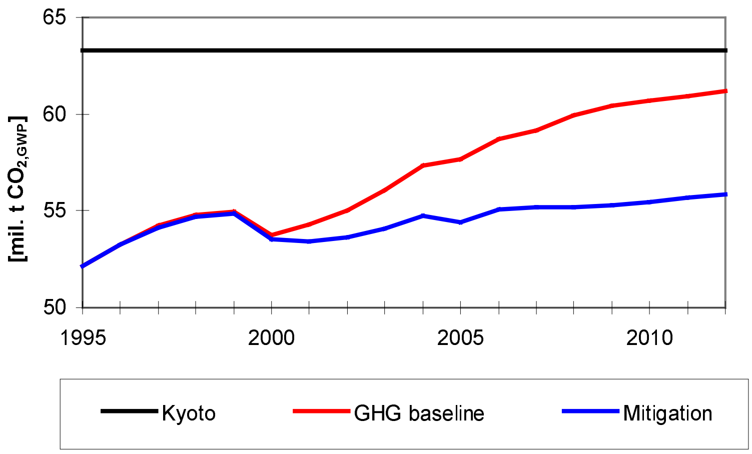
[25] According the Article 6 and Article 17 of Kyoto Protocol

Figure 5.7 Emissions scenario for other GHGs



Energy-related CO_2 emissions in 1990 were 56585 kt $CO_{2,GWP}$ and the total aggregated emissions in that year were 68806 kt $CO_{2,GWP}$. For comparison, the Kyoto commitment is 63302 kt $CO_{2,GWP}$ by 2008–2012. Figure 5.8 illustrates the possible impact of other GHG emissions on the total GHG offset at a baseline scenario and a scenario with mitigation measures adopted.

Figure 5.8 Impact of non-CO_2 GHG emissions on the GHG offset



This analysis suggests that emissions of other GHGs will not significantly change the total emissions offset. On the other hand, we must recognize that the emissions inventory of other GHGs for the base year as well as emissions projections have much higher uncertainties than for energy-related CO_2. Therefore, some new inventory methods and additional analyses could substantially influence our estimate of the projected offset level.

Two crucial factors discussed in this study are the schedule for implementing the new mitigation concepts (JI, AT) and the design of emissions market rules. In Chapter 3, we speculated that some rules will enter into force after COP-4 in Buenos Aires (1998), perhaps clarifying the allowable share of emissions reduction which could be transferred via JI or AT between the host and investor country. Other questions should be discussed before a market mechanism is settled, such as the volume of offset on the host side that can be a subject of trading, or whether the market will be based on MACs or on the willingness to pay.

Analyses of possible trading potential and financial flows have been carried out considering the following boundaries and limitations:

1) Financial flow was based on an ERU price equal to the investor's willingness to pay at a level of 25USD/t CO_2;[26]
2) Periods of JI and/or AT were considered from 2001–2012 and 2008–2012, respectively;
3) The volume of emissions reduction for JI and/or AT are listed as:
   - the whole available offset of aggregated GHGs ("Aggr. GHG")
   - the whole available offset of energy-related CO_2 emissions. The offset was considered to a level of 92% of energy-related CO_2 in the year 1990 ("Energy CO_2");
   - the offset created by all types of mitigation measures ("Mitigation");
   - the offset created by mitigation measures is obtained by the step-wise exclusion of measures in descending order of MAC.

Table 5.6 Tradable offset and financial flow for 25USD/t CO_2 willingness to pay

Option	*period 2008 - 2012*		*period 2001 - 2012*		*Comments,*
	thous. t/a	*mil USD*	*thous. t/a*	*mil USD*	*excluded measures*
Aggr. GHG	39025	976	101634	2541	
Energy CO_2	35598	890	86646	2166	
Mitigation	25684	642	43410	1085	
option 1	21907	548	32017	800	industrial CC
option 2	18677	467	26973	674	previous + geothermal
option 3	17258	431	23744	594	previous + small CC
option 4	15636	391	21902	548	previous + fuel switch
option 5	9846	246	11651	291	previous + DS option

5.7 Recommendation for a National Policy towards JI and/or AT

A national strategy towards emissions trading and crediting will strongly depend on the results of international negotiations related to GHG mitigation concepts. Expert groups should transfer articles of the Kyoto Protocol dealing with ERUs, CDM, and allowance trading (discussed in Chapter 1) to legally binding instruments.

Suggestions for clarification of this process include:
- The time schedule, especially when JI and/or AT will enter into force
- Approval and regulation of the limits on emissions trading from the national balance
- Whether price should it be based on the host's MACs or the investor's willingness to pay

The Slovak Republic, focused on new concepts of GHG mitigation, should accept the subsequent standpoints:

1. Starting JI and/or AT in the year 2001 would be ideal for Slovakia. In the period before 2008, autonomous development will create a sufficient emissions offset so that the impact of uncertainties can be omitted. There are not any binding commitments in the period prior to 2008 and emissions transfer to the investor country would not bring any complications. The period before the year 2008 could therefore be used as a learning period for JI and/or AT mechanisms.

2. The share of created emissions offsets that could be transferred to the investor country will be crucial in the period 2008–2012, when the autonomous offset will be lower. Furthermore, uncertainties in future development must also be considered. On the other hand, investor countries will probably be interested in emissions transfer during this period. Investors seeking emissions trades under AIJ will do so primarily to obtain credit in the period 2008–2012. Previous analysis has shown that the later JI and/or AT comes into force, the more difficult it will be to overcome barriers to the adoption of JI projects.

3. Emissions trading (JI and/or AT) will probably be based on typical market rules and the negotiation price should thus be close to the willingness to pay level. Consequently, the ERUs

[26] Expert estimation, based on the analysis issued in Chapter 3 for emissions trading with WE region.

should be shared between the host and investor country so that incomes from emissions trading will be equal to the financial term of barriers. In other words, the negotiation price will be higher than abatement costs, and the transfer of ERUs to the investor country will ensure this financial income. Effective use of this mechanism will require adequate capacity in the host country, preferably capacity that was nurtured during the learning phase before 2008.

In light of the above points, the following approaches should be considered in the SR:

I. A large-scale credit or allowance trading system can be feasible only after a learning period, where only smaller projects would be pursued (as in the AIJ pilot phase). Nevertheless, if negotiations about emissions transfers on the basis of abatement costs and willingness to pay will enable early, mutually beneficial sharing of ERUs, the project scale should not be limited arbitrarily.

II. The "learning period" before 2008 should be used to develop the skills, human resources, and institutions necessary for an effective emissions transfer program.

III. During the learning period, SR institutions should improve the GHG emissions inventory system, especially for non-CO_2 emissions (see Chapter 4).

IV. Of all the project types focused on energy-related CO_2 abatement, the projects based on fuel switching (preferably biomass), small hydropower, and geothermal energy should be given higher preference.

V. Projects in the previous paragraph (IV) represent specific sector projects for which the risk of emissions leakage into other sectors is lower. Implementing small hydropower plants on a small scale will replace only imported electricity, yielding no decrease in CO_2 emissions. This risk can be diminished by simultaneous implementation of other measures aimed at public electricity use (combined cycle turbines, DSM, etc.).

VI. Cogeneration has very site-specific characteristics and, therefore, public utilities could help clarify the fuel mix of the potentially replaced grid electricity. The actual level of achieved ERUs and their MACs can be better quantified in this way.

VII. Although MACs vary by project (and in specific cases have negative values), contracted financial flow must be sufficient to surpass implementation barriers.

VIII. Area mitigation options—such as those focused on decreasing residential energy demand—should be used for allowance trading. The mechanism of financial income recycling must be carefully prepared with a proper system of monitoring and verification.

6. JOINT IMPLEMENTATION PROJECTS IN THE SLOVAK REPUBLIC

This chapter summarizes the important information on possible adoption of Joint Implementation (JI) projects in Slovakia, including:

- ***Overview of the Slovak JI strategy (section 6.1)***
- ***Methods of participation in Slovak JI projects (section 6.2)***
- ***Description of how JI projects could be implemented (section 6.3)***
- ***Methodological instructions on how to determine financial and environmental effects of JI projects, and their compliance with Slovak eligibility criteria (section 6.4)***
- ***Detailed description of all Slovak JI projects which are open to investment at the moment (section 6.5)***

The project pipeline consists of seven projects that differ in level of total CO_2 emissions reduction, in life cycle, and in the level of individual CO_2 abatement costs (USD/tCO_2). Five projects entail a fuel switch from coal or heavy fuel oil to waste wood or natural gas, combined with energy efficiency improvement. The remaining two entail switching from coal or natural gas to geothermal energy. This Project pipeline is being prepared for dissemination on an Internet site. The methodology of project assessment developed in this study can be applied to other GHG mitigation projects.

6.1 *Introduction*

6.1.1 Joint Implementation

Joint Implementation (JI) is an instrument for the efficient mitigation of global climate change. It allows international investors to engage in climate protection projects abroad and to receive credits for avoided greenhouse gas emissions.

Joint Implementation is a means to:

- encourage the sharing of technologies and application of technologies in novel settings;
- achieve economically efficient reductions of global greenhouse gas emissions;
- encourage sustainable development;
- motivate private sector investment in environmentally sound projects in countries with economies in transition and in developing countries through the Clean Development Mechanism (CDM).

JI should be targeted toward those projects that are consistent with the environmental and public health priorities of the host communities and countries. The idea of JI is anchored in the United Nations Framework Convention on Climate Change (UNFCCC) and was endorsed at the Kyoto Conference in December 1997 (See Chapter 1).

6.1.2 Slovak JI Strategy and GHG Offset Potential

Analysis of energy-related CO_2 emissions scenarios brings the following findings:

I. Only scenarios with a low GDP growth rate will enable us to satisfy our Kyoto reduction commitments with no additional measures.

II. Higher exploitation of nuclear power and autonomous energy efficiency improvement (AEEI) by 5% in the industrial sector can ensure compliance with Kyoto reduction commitments compliance under a high-GDP-growth scenario.

III. Scenarios with a low GDP growth rate and high share of nuclear energy use (4 new units in NPP Mochovce) are questionable. These cases require additional installation of combined cycle turbines for public electricity generation. This action could increase NG import requirements and also decrease the scope for JI projects based on fuel switching.

An analysis of impacts and possible penetration of JI projects into the energy system shows that there could be some problems, maybe specific to Slovakia, resulting in emissions offset allocation:

⇒ The Slovak Republic imports some electricity. CO_2 mitigation options focused on decreasing electricity demand from the public grid (*e.g.*, independent producers with CC, demand side energy conservation) would thus lead to declining electricity imports without any impact on the national CO_2 emissions level.

⇒ Allocating offsets from demand-side energy conservation programs can be problematic. While the financial benefit goes to the energy consumer, the offset is created on the supply side.

Type of projects that have the offset and financial incomes allocated in the same place include:

a) Fuel switching (*e.g.* coal to NG or biomass);
b) Implementation of combined cycles (CC) in the industrial sector and concomitant replacement of existing coal- or oil-fired centralized heat and electricity plants (CHP);
c) Use of geothermal energy in facilities with a local heat source

Combined cycle generation and small hydropower development could bring benefits if they penetrate sufficiently to allow some offset of domestic fossil-fueled electricity generation. In addition, extremely high increases of electricity generation by independent producers could decrease the electricity generation demand enough to reduce the share of non-fossil electricity generation (large hydropower and nuclear power).[27] Therefore, the proposed institutional framework (see Chapter 4) must involve a proper GHG emissions inventory system based on the bottom-up approach in order to discover the *emissions leakage* from the selected project to other sectors. All

[27] The share of imported electricity replaced by electricity from implemented CC or small HPP will depend on the ratio of imported electricity purchase price to the production cost.

projects currently in the pipeline comply with the suggestion that offset allocation and financial benefits accrue to one entity, and can therefore be easily adopted prior to 2008.

6.1.3 Requirements for JI Projects in Slovakia

To be eligible for JI, projects should meet the following criteria:

A. Criteria set out in Article 6 of the Kyoto Protocol and in Decision 5 of COP-1

- The project must provide "a reduction in emissions by sources, or an enhancement of removals by sinks, that is additional to any that would otherwise occur".
- The project should be compatible with and supportive of national environment and development strategies, and contribute to cost-effectiveness in achieving global benefits.
- Approval of involved Parties (national governments) is required.
- Emissions, and emission reductions, must be calculated according to IPCC[28] guidelines.

B. Additional Slovakian requirements:

- Admitted project types.
- Abatement costs must be lower than the investor's willingness to pay.
- Use of Best Available Technologies Not Entailing Excessive Cost (BATNEEC) for the new and retrofitted units to meet emission standards (see Chapter 4).
  - ⇒ new technologies must meet emission standards of base pollutants (NO_x, SO_2, CO, solid particles, VOC, and others). Within Slovakia, existing units must meet these standards within a strictly determined period;
  - ⇒ improvement of local environmental situation;
  - ⇒ high efficiency of energy use;
  - ⇒ acceptable costs for modern energy technology implementation (Low-NO_x burners, desulfurization, precipitators, etc.)
- JI projects must bring real, measurable and long-term environmental benefits related to the mitigation of climate change.

6.2 Possibilities to Participate in JI Projects

6.2.1 Investing Funds

Possible investment models include:

- joint ventures
- equity investments
- purchase of emissions credits
- mutual funds

The World Bank's Prototype Carbon Fund (PCF) of the Global Carbon Initiative (GCI) could play a large role in the initial stages of JI funding. This fund will be increasingly tailored to the needs of investors and host countries to accelerate the application of new concepts, improvement of information flows, and reduction of transaction costs could be achieved (see Chapter 3).

6.2.2 Filing Project Proposals

The first step in proposing a JI project is submission of a completed Uniform Reporting Form, which is necessary for Pre-Qualification (see Section 6.3.2 for an overview).

[28]Intergovernmental Panel on Climate Change; the main body of scientific advice to the COP (via SBSTA)

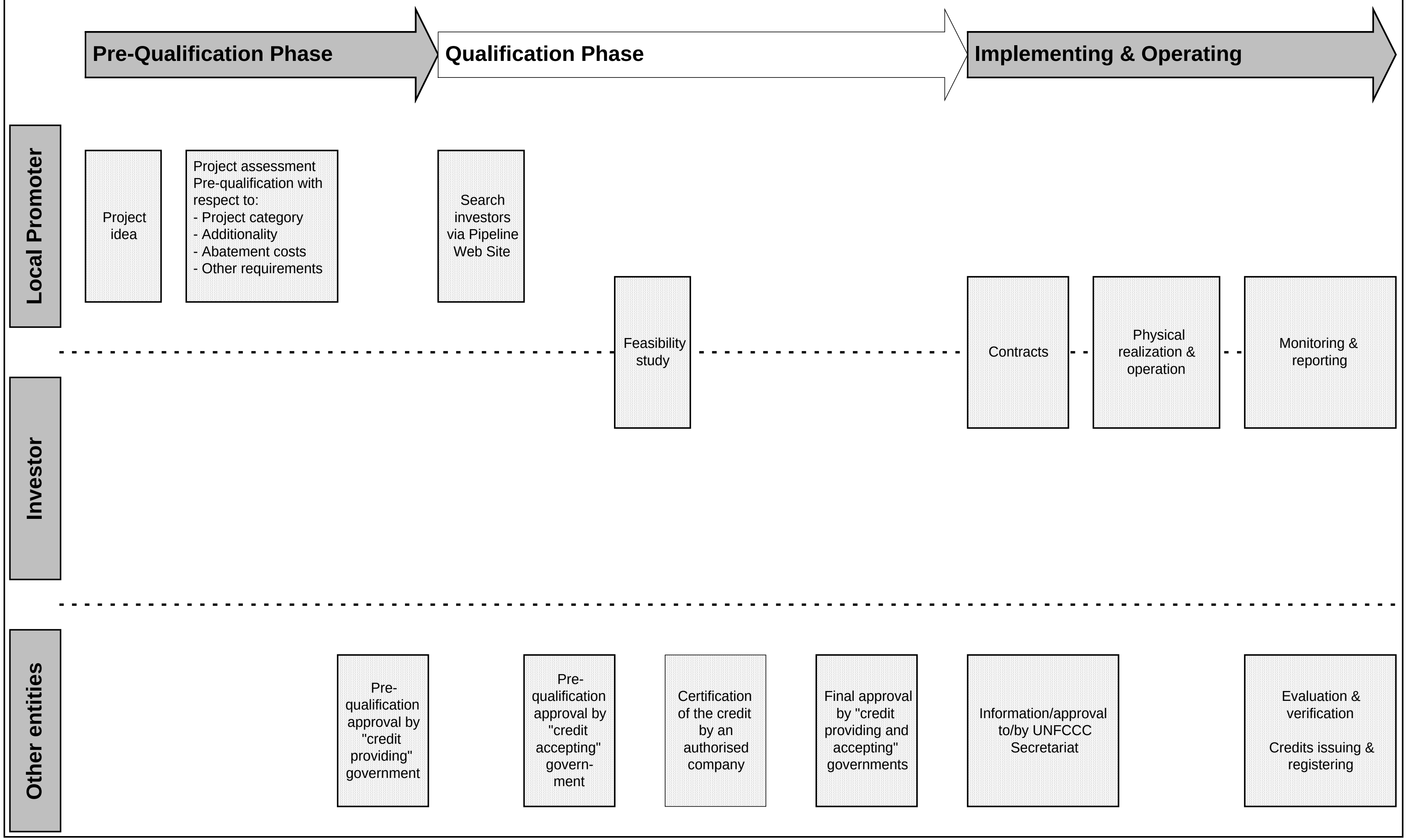
6.3 Implementing JI Projects

6.3.1 Overview of Implementation Steps (Chronological Order)

The following figure illustrates the steps needed for project implementation.

Implementing JI Projects

Overview on implementation steps.



6.3.2 *Pre-Qualification*

Pre-Qualification serves to determine whether a project is suitable for JI. The Slovak government should grant pre-qualification within the procedural framework described in Chapter 4. The applicant should submit the necessary information using the Uniform AIJ Reporting Format (see Section 6.9). Following governmental pre-qualification approval, the project shall enter the pilot project pipeline. The Web Site will provide one avenue for further information dissemination.

The PCF will probably require pre-project certification by an independent party to assure PCF participants of the soundness of the project and the credibility of the baseline. The pre-qualification process should address the following issues:

I. Credit volume and abatement cost
II. Need for foreign investment
III. Is GHG credit creation and financial income from JI allocated to the project owner?
IV. Impact on other GHG mitigation activities
V. Other environmental and socio-economic benefits

6.3.3 *Feasibility Studies*

The feasibility study should *inter alia* refine and extend the data submitted for Pre-Qualification. Again, the Uniform AIJ Reporting Format shall be used. Based on this revised data, Slovak and investor country governments may grant final approval for the JI project using the procedure described in Chapter 4.

6.3.4 *Governmental Approval*

Host and donor countries must approve JI projects prior to implementation. Governmental assessment of the project is based on data submitted in the Uniform AIJ Reporting Format.

6.3.5 *Contracts*

The contracting process is described in Section 6.8.1.

6.3.6 *Monitoring, Reporting, Evaluation, and Verification*

A consistent system of monitoring should be established on both the project and national levels. The latter is necessary to prevent emission leakage from the selected project(s) into other sectors, which is possible in the case of projects whose GHG offsets accrue to parties other than the project owner (for example, in the public electricity sector). Chapters 4 and 5 explain this problem more thoroughly. The recently developed Slovakian emission inventory system (NEIS, under the PHARE project) can play an important role in developing a sufficient monitoring system. Verification of project offsets may be delegated to external auditing companies who are certified by the Secretariat or by another entity. The details and schedule of this process are still undecided.

6.3.7 *Crediting*

The following parties are involved in establishing credits markets:

- The *Project Owner* would be a private, public or governmental organization hosting the investments.
- The *Investor* from the country with the GHG credit demand should be a private entity and/or a government agency.
- An *International Creditor* would play an important role in stimulating the credit market. We believe that the PCF of World Bank could act effectively in this capacity, especially in the inception phase.
- A *Certified Verification Organization* could be either the Secretariat or an independent certification company.

The time frame of crediting should be set at the beginning of each project. Verification of the offset value should be made annually. Because of the Kyoto commitments, credit transfers prior the year 2008 have a different weight than transfers during 2008–2012.

6.3.8 *Liability*

In some cases, the actual, verified GHG offsets achieved by the project could be less than original estimates. This possibility raises the question of risk sharing between the investor and project owner. Our analysis indicates the following possible sources of risk:

⇒ Technical design of project will not bring the expected credit amount;
⇒ Energy demand could be lower initial forecasts;
⇒ Local conditions could favor other energy systems and structures of final energy uses;
⇒ National economic performance could differ from that chosen for the baseline;
⇒ In EIT countries, privatization can alter sectoral economic activity and lead to changes in facility ownership.

In the inception phase, PCF can help diffuse these risks. However, additional recommendations include:

- Limited time schedule of crediting;
- Creation of credit insurance system on the international level (perhaps within the framework of PCF).

The AIJ pilot phase should be used to evaluate these uncertainties and experiment with the international insurance system.

6.4 *Characterizing JI Projects*

This section contains methodological instructions on how to characterize JI projects. JI projects can be characterized according to

- Project category;
- Expected or achieved greenhouse gas (GHG) offsets;
- Costs of implementation;
- Additionality of emission reductions;
- Compliance with national and international requirements ("eligibility").

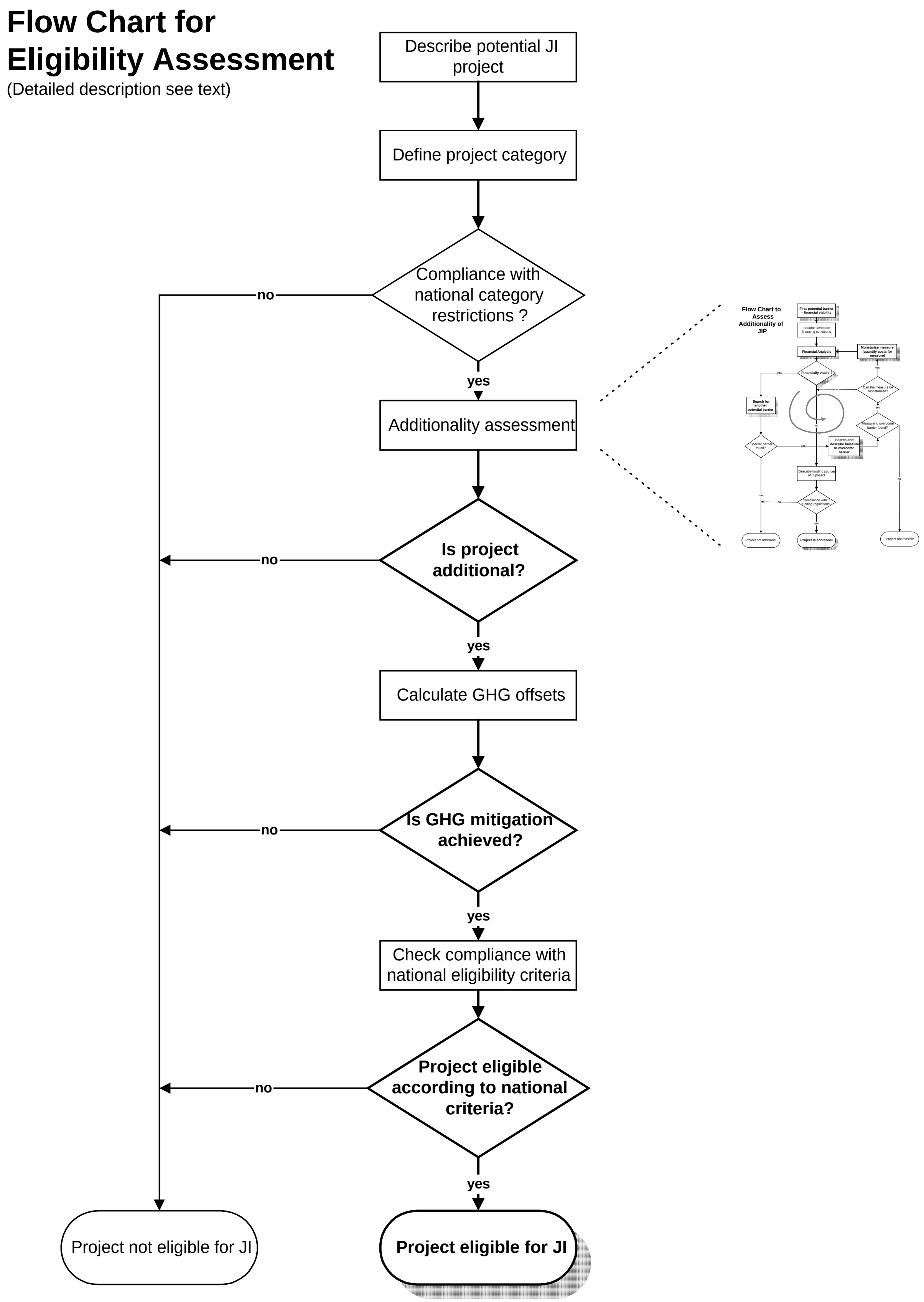
The results of characterization should be presented in standardized form like the Uniform AIJ Reporting Format (Chapter 6.9).

As outlined in Section 6.3 of this report, characterization is to be carried out in two steps:
(1) The Pre-Qualification phase (see Section 6.3.2) will establish a draft characterization to determine whether the project is eligible for JI according to Slovak standards. Efforts for this step should be minimal but reliable.
(2) The Feasibility Study will characterize the project in more detail once interested investors have been found.

6.4.1 *Overview of Characterization Steps*

Project characterization should be executed in a stepwise approach in which the results of each individual step should immediately be checked against relevant eligibility criteria. This process will expedite the elimination of unqualified projects. Figure 6.1 outlines the links between project characterization and eligibility evaluation.

Figure 6.4: *Stepwise project characterization and determination of project eligibility for JI. The methodology of the individual steps are further outlined in Sections 4.2 to 4.8 of this document.*



6.4.2 *Project Category*

The first step in the characterization process will assign the proposed project to a distinct category. This classification is necessary because (a) national regulations may exclude certain project categories from JI, and (b) methodological instructions in the following sections of this chapter may vary according to the category of the project under consideration.

The IPCC has proposed classification categories:

- ⇒ Energy efficiency
- ⇒ Renewable energy
- ⇒ Fuel switching
- ⇒ Forest preservation, restoration or reforestation
- ⇒ Afforestation
- ⇒ Fugitive gas capture
- ⇒ Industrial processes
- ⇒ Solvents
- ⇒ Agriculture
- ⇒ Waste disposal or bunker fuels

6.4.3 *Technical Description*

Requirements concerning the technical description of JI projects must be formulated for each project category. A minimum description of project, however, should include:

- Project category
- Description of current technology
- Description of proposed technology
- Efficiency
- Fuel type
- Demand/production analysis

6.4.3.1 Energy Sector

A minimum description of energy-related projects, such as heat or electricity production, should include:

- output analysis, including peak capacity and yearly production;
- input analysis, including fuel demand, and expected conversion efficiency;
- transport losses.

Data would ideally be presented in a spreadsheet that includes relevant economic data (fuel costs, operation and investment costs, renewals, etc.) and emission values. Establishing a concise output analysis is essential for the correct identification of the JI project's baseline.

6.4.4 *Project Time*

Project time is the maximum expected duration of the JI project. This time interval can be estimated based on:

- the lifetime of the shorter-lived technical project components
- maximum project length for which baseline assumptions can be made with some reliability.

6.4.5 *Identification of the Project Baseline*

Establishing a completely general methodology for the correct identification of baselines is difficult if not impossible. Thus, methodologies should be drafted individually for each project category. Recall that the baseline is defined as the probable situation if the JI project were not implemented. Since the baseline is the basis for the calculation of GHG offsets and abatement costs, it should be identified carefully. A correct baseline will yield an optimum match with the JI project, such as describing output characteristics in energy-conversion projects. The following aspects must be explicitly considered when identifying the baseline:

- *Current situation*: Could the status quo be maintained without significant investments, or will large investments inevitably be necessary during the lifetime of the JI project?
- *Existing plans for alternative projects* that are external to JI;
- *Existing development plans:* The technology chosen for the reference project should represent the most desirable marginal addition to the Slovak economy and not merely reproduce average technology.
- *Existing barriers* for project implementation.

A project can conceivably have several potential baselines. In this case, the barrier approach (see Section 6.7.8) can be a useful tool to identify the most appropriate one: given several baseline options, the one with the fewest barriers can qualify as the actual baseline.

6.4.5.1 Baselines for Heat Production

- If the status quo is a possible baseline option, relevant institutions should determine whether this status quo could technically be maintained for the period under consideration, or whether breakdowns or decreasing efficiencies must be expected.
- Risks of complete breakdown of the existing installations may be incorporated by assuming a baseline switch at a well-defined point of the JI activity. For instance, the existing status could be used as the baseline for the first half of the JI activity, followed by a switch to best available technology, which could be as or even more efficient than the JI technology.

6.4.5.2 Baselines for Electricity Production

The methodology for establishing baselines in electricity production projects may vary according to the scale of the project. Large-scale projects may be qualitatively described as projects that exert significant influence on national power generation, *e.g.* by replacing another large plant. The baseline identification procedure for such large-scale projects should be based on national power development plans. For small-scale projects, short-term and long-term evaluations are possible. The choice between the two options could, for instance, rely on the electricity demand and supply situation.

In the short-term case, projections for a baseline depend on whether the additional JI project power will replace electricity currently produced in other facilities or lead to an increase in consumption due to locally unsatisfied demand. In the latter case, the JI project may lead to an increase in GHG emissions unless some other power development project is directly replaced. In this scenario, GHG emission factors from an "average" plant may be assumed as the baseline. Over the long-term, a small-scale JI project may contribute to the replacement of an additional large power plant with similar production characteristics (*e.g.,* a similar load curve). In that case, small-scale projects may be treated as large-scale projects.)

In the Slovak Republic, current status may be considered a baseline. However, this status quo baseline should include any system retrofits (for example, using low sulfur coal and installing new abatement elements) mandated by existing environmental and air quality legislation. Furthermore, additional maintenance is needed to ensure full operational life. All investment, operation, and maintenance costs should thus be included in economic evaluations for the baseline scenario.

6.4.5.3 Relationship between Baseline and Crediting

The negative effects of incorrect baseline determination can be addressed by revaluing the project baseline during the JI activity. In this case, investors would have to be compensated for the corresponding risk increase (due to possible loss of credits), perhaps by applying favorable credit calculation schemes for those investors who choose baseline revaluation. Revaluation of the baseline could mitigate risks; for example, emissions will decrease if electricity and heating use decrease from initial expectations.

6.4.6 GHG Emissions

Determining the GHG offsets achieved by a JI project requires calculation of both project and baseline emissions. The results of these emission calculations depend on the definition of the system boundaries:

- ***Pre-combustion stages:*** In the energy sector, the pre-combustion stages of the fuel use (fuel production and transport; production, erection and disposal of technical infrastructure) could contribute significantly to overall GHG emissions at the national level.
- ***Other greenhouse gases:*** In the energy conversion sector, CH_4 emissions are likely to affect the calculations if the pre-combustion stages are not included. In agricultural projects, CH_4 and N_2O may even be the dominant gases.

As long as these issues are not regulated internationally, we suggest including pre-combustion and selected other (non-CO_2) GHGs in emissions calculations on the conditions that (i) overall emission calculations are significantly influenced and (ii) reliable data are available. Currently, the relevant data collection is carried out in Slovakia under the IAEA; nevertheless, we did not include these data in our analysis.

Another crucial parameter in the GHG emission calculation is the efficiency of technical installations. Of course, calculations should wherever possible use real efficiencies instead of theoretical optimum efficiencies. For instance, real efficiencies in power generation depend on production characteristics, such as the frequency of cold and hot starts. Another aspect is the development of efficiencies over time. Assuming constant efficiencies of technical installations requires estimates of the financial expenditures required to maintain these efficiencies. Alternatively, calculations may assume decreasing efficiencies over time.

6.4.7 Cost Calculations

Costs and benefits should be calculated for both the JI and the baseline projects in order to determine financial viability and GHG abatement cost. A high degree of transparency is of special importance in these calculations; thus, all underlying assumptions should be explicitly stated, especially those concerning

- investments (amount, timing)
- discount rate
- financing conditions (loan or grant; interest rates; grace period, redemption time)
- yearly operation costs and assumed development of fuel prices
- maintenance costs (e.g. constant vs. declining efficiency)
- returns from sales
- returns from subsidies

Project costs and benefits should be calculated from the investor's viewpoint and expressed as the net present value (NPV) of the project. The NPV may depend on the expected barriers to the project. The concept of barriers is explained in detail below. Examples for barriers are (i) high project performance risks, and (ii) lack of local technical knowledge about the JI technology.

For the sake of maximum transparency, we propose a scheme that explicitly states the financial impact of project barriers. As a start, the NPV of a project may be calculated assuming a favorable discount rate and neglecting barrier effects. Then, the financial analysis may be extended to include the financial impacts of project barriers. For the above examples, estimates could be given on (i) the impact of the performance risk on the discount rate which an investor would apply; and (ii) financial expenditures for the training of the local staff.

Table 6.5: Possible scheme to state project costs and benefits with separate barrier costs

	NPV	*Year 0*	*Year 1*	*Year 2*	...	*Year X*
Benefits						
Returns from heat sales						
Other returns ...						
Asset values ...						
Costs						
Investments						
Operation						
Maintenance						
Total (without barrier costs)						
Barrier Costs						
Barrier No 1		(Specify the barrier and indicate the amount and year of costs, or its impact on the discount rate)				
Barrier No ...						
Total (including barrier costs)						

6.4.8 Additionality

To be eligible for JI, the project must fulfil the criterion of additionality, that is, that the expected mitigation effect would not have occurred without the JI project: "The project must bring about benefits related to the mitigation of climate change that would not have occurred in the absence of such activities" [Decision 5, COP-1].

Several approaches exist to determine whether a project is additional [see Carter 1997]. We advocate the IEA's so-called barrier approach, which is based on the following principles [IEA 1997: 8,22]:

- Climate protection projects can encounter various obstacles or barriers;
- To qualify as additional, a JI project must overcome specific barriers that are not encountered in the baseline project. Whether a barrier is specific or not is determined in a *comparative barrier assessment* of the JI and the baseline projects;
- Measures to overcome the barrier(s) must be demonstrated.

In our opinion, many potential barriers to JI are not exclusive to one project but rather increase project costs generally because they require additional financial efforts. In other words, most barriers can be overcome financially, thereby increasing the financial viability of the project. We, consequently, suggest extending the IEA approach as follows:

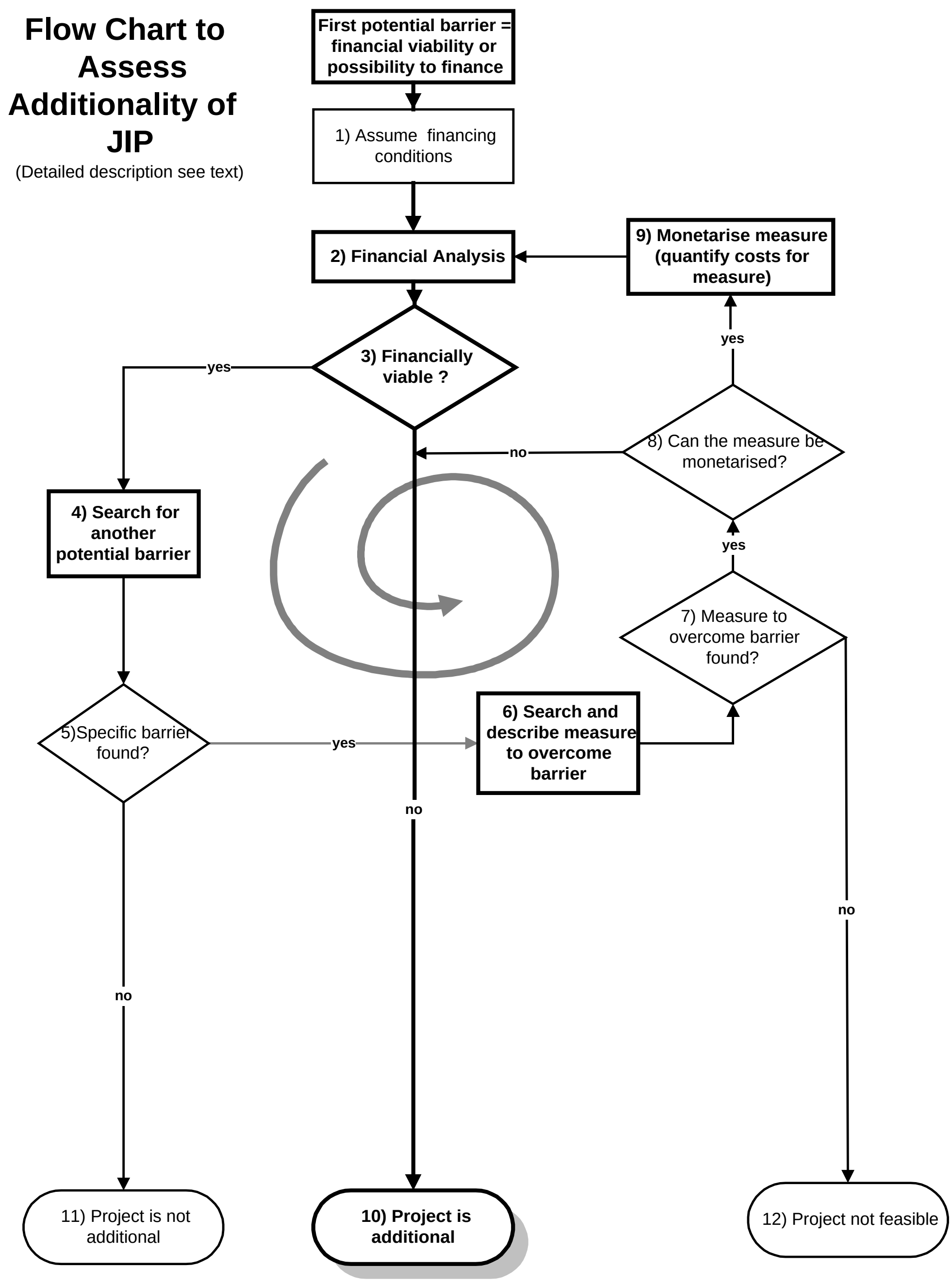
- The financial viability of the project can be considered the dominant criterion in the additionality assessment;
- Many small barriers will not suffice to guarantee project additionality. However, the financial impacts of the measures to overcome these barriers can be included in the financial analysis of the project.
- Barriers that can only be overcome by non-financial measures can also determine additionality, for instance if the measures are specific to JI.

In accordance with the IEA, we think that the existence of one significant barrier suffices to demonstrate project additionality. The additionality assessment may thus be restricted to a few barriers, or even to the financial analysis alone. However, a comprehensive assessment that includes all types of barriers may also yield important insights on project feasibility, since barriers may be discovered that inhibit project implementation. In addition, a barrier analysis may also be used to determine which baseline option is the most realistic.

6.4.8.1 Methodology of Additionality Assessment

The first step in additionality assessment comprises a simple financial analysis assuming favorable local financing conditions; potential returns from GHG offset credits are not included. A negative Net Present Value (NPV) for the project at this stage indicates a major barrier and thus demonstrates additionality. If the project seems financially viable, other barriers should be investigated. The financial effects of these barrier and measures to overcome them should be incorporated in the financial analysis. This procedure is continued in a step-wise approach until a barrier a) can only be overcome by a measure that leads to financial non-viability of the whole project, or b) can only be overcome by a non-financial measure. This procedure of additionality assessment is outlined in Figure

Figure 6 2: Flow chart for additionality assessment of JI projects.
Source: modified from IEA, 1997



6.4.8.2 Detailed Description of Additionality Assessment (Numbers According to Flow Chart Diagram)

(1) Assume the most favorable financing conditions that can possibly be encountered in the project, neglecting, for instance, the financial impacts of project-specific risks.
(2) Carry out a first simple financial analysis considering only direct costs and benefits of the project (including investment, financial, operation, and maintenance costs). Calculate the Net Present Value (NPV) of the project by a cost-benefit analysis. Calculate the incremental costs.
(3) If the calculated NPV is positive, the project is financially viable
(4) If the calculated NPV is negative, the project is not financially viable → (9).
(5) Search for specific barriers to the project. The following list with examples can help to identify specific barriers:

Categories of Potential Barriers	***Example of Barriers***
Technology related	maintenance risks
	availability
	performance risks
Institutional/legal	project delay risks
	high hurdles for foreign direct investment
	subsidies for gas or heat
Financing related	lack of long term capital
	higher costs of foreign capital
	exchange rate risks
Market related	raw material supply risks
	uncertain development of fuel price
Knowledge related	inexperienced with technology
	lack of qualified personnel
	lacking information of project opportunity

Note: *It is important that the identified barrier does not affect the defined baseline as well. Barriers that affect both the JI-project and the baseline case are not specific JI barriers and therefore not accepted as additional.*

(5) Was a specific JI barrier found? Yes → (6), no →any JI-project (11).
(6) Search for measure to overcome barrier. Example: "Lack of qualified personnel" was identified as the specific JI barrier. A training program in the host country for the involved people presents one way to overcome this barrier.
(7) If a measure to overcome the barrier was found → (8), if not → project is not feasible (12).
(8) If the solution to the barrier is a financial measure (e.g. financing a training program) → a new, more detailed financial analysis should be performed (including the costs of the measure) along with calculation of incremental costs (3). If the solution is not a financial measure → (9).

6.4.9 Negotiation of Credits

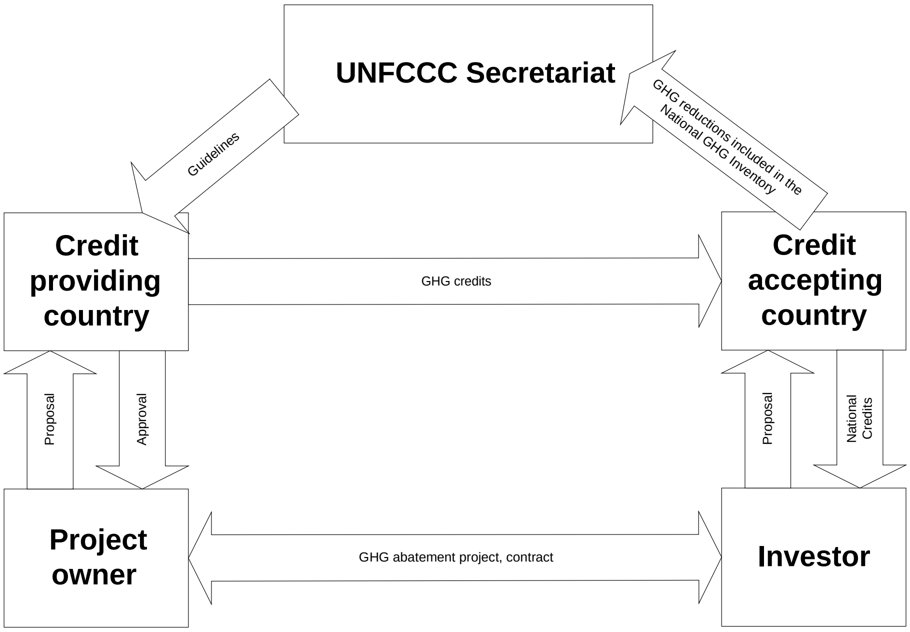
The following terms appear in the following figure and the accompanying text.

- *Credit Providing Country* (CPC): the host country in which a JI project is realized.
- *Credit Accepting Country* (CAC): the investor country to which the GHG credits are transferred after verification by the Secretariat.
- *Project Owner*: a private company, a communal entity, or a state-owned facility.
- *Investor*: The private sector and government are involved in both the AIJ pilot phase and in JI for credits.

- *Verification Period*: the time interval during verification of project performance.
- *Project Time*: the total time for which a JI contract is negotiated (commercial lifetime).
- *Baseline*: the determination of the baseline requires an economic analysis. The baseline emissions result from technology that would be applied in a baseline project.

6.4.9.1 The Mechanism of JI Contracting

The following figure depicts a possible contracting mechanism:



Step 1: Pre-qualification

The Project Owner submits a proposal to the government of his country (the CPC) estimating costs and possible GHG credits of a JI project. (He may hire an external consultant to expedite this task.) The Project Owner and CPC government agency will then determine what investments should be secured outside of a JI scheme in order to bring an existing facility up to baseline standards. The CPC may also consider implementing the whole project outside the JI scheme and adding the resulting GHG credits to its own credit. This will be particularly worthwhile when substantial GHG credits can be earned by relatively small investments ("low hanging fruits"). If the proposal passes these tests, the government agency responsible for GHG crediting grants it preliminary approval.

Step 2: First contact with a possible Investor

Contacts with Investors can be initiated by publishing a list of projects that are pre-qualified by the CPC. The CPC could enhance information availability for Investors by establishing an Internet web site. In addition, personal contacts of the Project Owner, activities of the CPC Diplomats and other networking activities will certainly be of importance.

Step 3: Negotiations of Credits and Verification Period between Investor and CAC

Once an Investor has decided to search a JI candidate project in a certain area, he will have to determine the credits given to him by the CAC (for example, in the form of tax breaks). He will thus contact the responsible agency of the CAC. The CAC will be the country in which the Investor is located. An important part of these negotiations will be an agreement about Verification Periods. In section 2 below this point is discussed in some detail.

Step 4: Negotiation of Project Time between Project Owner, Investor and CPC

The total running time of the contract (Project Time) must be approved by the CPC. It is in the CPC's interest to keep Project Times short: once a JI project has been terminated, the resulting GHG savings will not be transferred to an outside partner (the CAC) but will remain in the country. It could then, for example, be traded away. Step 4 will be discussed in more detail in Chapter 3 below.

Step 5: Negotiations between Investor and Project Owner

Negotiations establish the technical specifications of the project, guarantees, and other provisions. The Project Owner and Investor are fully responsible for these contracts and no interference from outside parties is necessary. The government agencies involved and the Secretariat shall be informed of the final contract.

Step 6: Final Approval

Independent, qualified certification companies will certify the baseline and the GHG credits transferred from the CPC to the CAC. Before approval, the Secretariat will consider whether the technical solutions negotiated in step 5 are supported by actual technical knowledge and whether the verification procedures and baseline are plausible. After this step, the CAC can approve the crediting scheme and the CPC can approve the Project Time.

6.4.9.2 Negotiating of Verification Period (Step 3)

Example 1: High risk of noncompliance

An Investor is interested in securing GHG credits with the minimal verification acceptable for a JI project (for example, verification every five years). He intends to receive credits by the CAC government in the form of tax reductions. From the point of view of the CAC, such an investment presents a considerable risk of non-compliance. If verification after five years shows that the project does not perform as expected, the CAC may receive a much smaller GHG credit than negotiated and several years' worth of tax credits may have been erroneously allocated to the Investor. Instead of setting up a scheme for fines and payback of credits, we suggest that the CAC allocate less than the full GHG credit to the Investor—for example, 60% of the full credit—and thus insures against the risk of non-compliance. After verification, 100% of the verified credit can be transferred to the CAC. The Investor does not receive any additional credits if the project's offsets exceed initial estimates; on the other hand, he need not return tax credits received during the Verification Period if the project performs below expectations. After verification, the Investor's credits for the second period are calculated based on the verified performance, of which 60% will be allocated to the Investor. Thus, if the project has performed better than expected, the Investor will receive higher credits for the second Verification Period and, conversely, when the project has performed below expectations, the Investor will receive lower credits for the second Verification Period than for the first.

Example 2: Normal risk of noncompliance

Should the Investor be willing to shorten the Verification Period in the contract to two years, there is a smaller risk of non-compliance. In this case, a higher percentage, say 90%, of the GHG credit for two years is allocated to the project by the CAC. The Investor must then also bear the higher costs for more frequent verification.

Example 3: Low risk of noncompliance

If the Investor willing to verify every year and pay the associated costs, it would receive 100% of the GHG credits estimated for the project.

This scheme distributes risk of non-compliance to both the Investor and CAC. In compensation for the risk incurred, the CAC receives the full GHG credit but pays less than the full tax credit to the Investor. Thus, when the project performs to specifications, the CAC receives 100% of the GHG credit for 60% of tax credits. On the other hand, in an under-performing project, the CAC may give away tax credits to an Investor without receiving much GHG credit in the end.

6.4.9.3 Negotiation of Project Time (Step 5)

A long Project Time is desirable for an Investor because a smoothly running project may have low marginal costs after initiation. On the other hand, an acceptable JI project has to provide technology with higher than average GHG efficiency. Thus, given the normal course of technical progress, JI project lifetime is limited: sooner or later a former "top notch" project will be standard technology and would not qualify for JI anymore. Furthermore, unlike in the setting of Verification Periods, the Credit Accepting Country (CAC) has no interest in limiting the Project Time as long as the produced GHG credits continue to be transferred. However, the CPC will be interested to "get the emissions back" as soon as possible. Once the GHG emissions reductions return to the CPC, they lower its GHG emission inventory; they could then be traded away to create additional income for the CPC. Therefore, in the contracting mechanism of contracting outlined in section 1, the CPC receives the authority to negotiate the Project Time.

Negotiating the Project Time involves setting the baseline for the Project Time. In most cases, the baseline will be assumed constant for the whole Project Time; in some cases, however, a time-dependent base line may be assumed. Once negotiated, the baseline cannot be changed. In order to give an Investor an incentive to settle for a shorter Project Time, the CPC can offer a baseline setting at the upper end of the acceptable range (see below) for a shorter Project Time, thus creating higher GHG credits for transfer to the CAC. This strategy is technically justified because a shorter Project Time translates into less uncertainty with respect to development of the baseline. Thus, the baseline can be set more favorably for the Investor, providing it remains within technically plausible limits.

A range for acceptable project times and plausible baseline settings should be set for each project. All projects that adhere to these ranges will be acceptable in the final approval step. The range should be based on technical plausibility. It should also be acceptable to the general public and outside parties like NGOs.

6.4.9.4 Summary

The most significant practical advantage of this scheme is that a reasonable estimation of costs for JI-credits can be given to Investors very early in the negotiations. When the Project Time acceptable to the CPC is known, the Project Owner can publish reliable estimates of the investment costs for JI credits at the pre-qualification stage. Once an Investor knows the conditions of his CAC and his desired project characteristics (Verification Periods, discounts for longer Verification Periods, and payment for the GHG credits transferred to the CAC), he can shop for suitable projects. He will be able to calculate potential financial benefits and to estimate risks based on data provided by his CAC and candidate CPCs. The shorter the Verification Period chosen by an Investor, the lower the average costs per unit weight of GHG emissions over Project Time and the higher the commercial losses/gains when the project performs worse/better than expected.

A second advantage to this scheme is that stepwise negotiation of project conditions will tend to correct implausible conditions. Defined project-specific ranges should be set almost exclusively on the basis of technical plausibility and should be negotiated with all parties interested in the JI mechanism, including NGOs.

6.4.10 Secondary Effects

Secondary effects should be quantified to determine whether the JI project complies with Slovak national JI eligibility criteria. JI projects should comply with estimates of these secondary effects.

6.5 Description of Available JI Projects

This section describes the projects that PROFING Comp. Ltd., has deemed the most suitable for the JI pipeline. The pipeline consists of seven projects that differ in the level of projected lifetime CO_2 emission reduction and in the level of individual CO_2-specific reduction costs (USD/tCO_2). Five projects entail a fuel switch (from coal or heavy fuel oil to waste wood or natural gas) combined with energy efficiency improvement. The remaining two entail switching from coal or natural gas to geothermal energy.

I. Temporal boundaries: We have assumed 20 years as the life cycle of JI projects; all calculations have been developed with this value.
II. Other boundaries: GHG offset calculations have been restricted to energy-related CO_2 emissions only. The secondary (pre-combustion) CO_2 emissions and emissions of other GHGs have been neglected.
III. Additionality assessment: All projects are not financially viable without additional financing. Capital costs present the main barrier to implement all the projects, as the necessary high capital flow cannot be mobilized from local sources even under favorable conditions. Above all, the high interest rate for short-term loans will cause negative cash flow at project implementation.

IV. Analyses of other barriers

A. Fuel switching from coal or heavy fuel oil to waste wood or natural gas, combined with energy efficiency improvement

⇒ *Capital costs* – necessary capital flow is very high and cannot be gained from the local financial sources under favorable conditions
⇒ *Performance risks* – none; technology is available and has been introduced many years ago
⇒ *Environmental risk* – test measurements and experiences in Slovakia indicate that by adopting this option we can simultaneously meet Slovakian emission air pollution standards with this type of projects
⇒ *Construction risks* – none
⇒ *Fuel supply security* – waste wood must be available in required amount (see Chapter 5)
⇒ *Operational issues* – none; technology is available and has been introduced many years ago
⇒ *Heat price risks* – Heat prices for residential consumers currently do not cover production costs, and the state subsidizes the difference. Governmental policy dictates that these subsidies will gradually be removed, bringing production costs in line with real economical conditions. We assume that residential consumers will not be able or disposed to pay higher district heating prices and might therefore switch to individual heat production (local boilers in houses or flats)

B. Fuel switching from coal or natural gas to geothermal energy

⇒ *Capital costs* - necessary capital costs are very high and cannot be received from the local financial sources under favorable conditions

⇒ *Performance risks* - technology is new; therefore, reliability and availability risks might be higher

⇒ *Environmental risks* - none, as geothermal energy produces no pollutants

⇒ *Construction risks* - unconventional technology, so construction risks might be higher

⇒ *Energy supply security* - geothermal energy must be available in the required amount

⇒ *Operational issues* - implementation of central heat supply system utilizing a geothermal energy will require extra effort from the staff

V. Baseline costs **-** Current status before project implementation includes retrofits required by environmental legislation (for example, switching to low sulfur coal with precipitators). Additional maintenance is also necessary to ensure operation to the end of capital lifetime. All these investment, operation, and maintenance costs have been included in economic calculations for baseline scenario.[29]

VI. Net present value and incremental costs of projects - net present values (NPV) for proposed and baseline projects have been calculated using comprehensive cost-benefit analyses with a 12% discount rate. Incremental costs have been established as the NPV differences between baseline and proposed projects at equal service conditions. Calculated incremental costs of proposed projects were positive in all analyzed cases, indicating that the proposed projects would be more expensive for owners than the baseline ones—if the owners had to pay the entire calculated investment sums. Positive incremental costs can be a good signal of project additionality (in view of Joint Implementation) for the proposed project.

VII. CO_2 abatement costs - have been calculated as a ratio of incremental costs (described above) and incremental CO_2 emissions (difference between CO_2 emissions of proposed project and baseline case).

VIII. Secondary effects - The proposed projects will likely have positive secondary impacts not directly related to CO_2 abatement:

- Improvement of the local environmental situation (*e.g.* by reducing air pollutant emissions)
- Creation of new jobs in the construction and installation business
- Transfer of modern energy technologies and knowledge to local economies
- Supporting information exchange through joint project performance and training programs
- Reduced demand for fossil fuel imports and consequent improvement in resource management
- Enhanced use of sustainable natural resources such as wood waste or geothermal energy

Negative secondary effects of the proposed projects are not expected. All proposed projects are therefore fully compatible with Slovak environmental and economic development strategies.

The next Section provides a brief review of JI projects in the prepared pipeline. Projects have been sorted into particular sectors according to sector list in Annex 1 of the TORs, July 30, 1997.

6.5.1 Energy Sector (Coal, Oil, Gas, Renewable)

6.5.1.1 The Use of Geothermal Potential in Košice Valley

General information

Item	***Please fill in if applicable***

[29] In the attached project description, baseline information is omitted in order to save space; nevertheless, it will be part of the actual JI project pipeline assessment.

Type of project:[a)]	fuel switch from coal to renewable energy
Location (exact, e.g. city, region, state):	City Košice; Slovak Republic
Activity starting date:	technical facilities operative from 1999 or later
Expected activity ending date:	2018
Stage of activity:[b)]	pre-feasibility study
Lifetime of activity if different from ending date:[c)]	2018 or later

JI Project

Item	*Please fill in if applicable*
General description (& acronyms used):	-replacement of part of heat generated in central heat supply source of Košice TEKO using the energy potential from geothermal source in Košice valley; -the central heat supply in Košice will be composed from the geothermal supply stations, the hot-water distribution system and dispatching centre
Technical data:[d)]	-the first stage proposal is based on the digging of 6-8 bores that allow us the thermal capacity of 110 MWth and enable us to get the yearly production of 2484 TJ, presently supplied from TEKO; -the capacity of one bore has been estimated at 65 l/s, which represents the mass flow of 61.5 kg/s at the temperature 125 °C.

Cost (to the extent possible)

Item	*total*
Start Investment Cost of the project in USD	49 150 522
Maintenance cost in USD/ year	498 705
Operation cost in USD/ year	2 002 051
Total cost in USD/20 years	89 191 548
AIJ component in USD/20 years	21 756 102
CO_2 avoided (see section E) in tons/a	253 809
USD per avoided ton of CO_2 equivalent	***4.29***

6.5.2 *Industry (including selected sub-sectors)*

6.5.2.1 Reconstruction of Boiler House Mincov□a Kremnica š.p.

General information

Item	*Please fill in if applicable*
Type of project:[a)]	Energy efficiency / fuel switching
Location (exact, e.g. city, region, state):	City Kremnica; Slovak Republic
Activity starting date:	technical facilities operative from 1999 or later
Expected activity ending date:	2018
Stage of activity:[b)]	project proposal
Lifetime of activity if different from ending date:[c)]	2018 or later

JI Project

Item	*Please fill in if applicable*
General description (& acronyms used):	-reconstruction of boiler house in Mincov□a Kremnica -heat production only for own plant without heat supplying hospital -fuel switch from heavy fuel oil to natural gas -installation of 3 gas boilers
Technical data:[d)]	3 natural gas-fired boilers; total power 3 MW_{th} heat production by the installations: 12 745 GJ/a

6.5.2.2 Reconstruction of Boiler House ZTS Hri□ová

General information

Item	*Please fill in if applicable*
Type of project:[a)]	Energy efficiency / fuel switching
Location (exact, e.g. city, region, state):	City Hri□ová ; Slovak Republic
Activity starting date:	technical facilities operative from 1999 or later
Expected activity ending date:	2018
Stage of activity:[b)]	project proposal
Lifetime of activity if different from ending date:[c)]	2018 or later

JI Project

Item	***Please fill in if applicable***
General description (& acronyms used):	reconstruction of boiler house in Z□S Hri□ovské strojárne, fuel switch from brown coal to natural gas, installation of 1 gas boiler and 282 infra-red warmers
Technical data:[d]	1 natural gas-fired boiler; power 6 MW_{th} 184 infra-red warmers á 35 kW(total power 6.4 MW_{th}) 98 infra-red warmers á 22 kW(total power 2.15 MW_{th}) Heat production by the installations - 146 745 GJ/a

6.5.2.3 *Heat and Electricity Cogeneration from Wood Waste and NG in BU□INA, A.S., Zvolen*

General information

Item	***Please fill in if applicable***
Type of project:[a]	Energy efficiency / fuel switching
Location (exact, e.g. city, region, state):	City Zvolen; Slovak Republic
Activity starting date:	technical facilities operative from 1999 or later
Expected activity ending date:	2018
Stage of activity:[b]	PHARE PROJECT 94/02-02-01-03
Lifetime of activity if different from ending date:[c]	2018 or later

JI Project

Item	*Please fill in if applicable*
General description (& acronyms used):	***-the implementation of measures*** focused on the following items: • the improvement of heat source energy efficiency by the retrofit of present one; • the retrofit of present heat distribution net; • use and distribution of energy carriers with higher efficiency; • automation of energy supply system. Heat demands will be covered by internal generation and supply of heat from CHP will not be necessary. ***-the implementation of combined cycle and dry cogeneration*** units in order to reduce the external electricity supply. Application of combined heat and electricity production units by using the wood waste and NG as the fuel input enables us to completely cover the electricity demands internally. Their design will be fitted to the condition of their technological uses. • dry cogeneration for particle board production (DTD) with installed electr. output of 3.5 MWe; • combined cycle (steam-gas cycle) for self heat and electricity cogeneration in company with electrical output of 3 MWe; • dry cogeneration for oriented strand board (OSB) with electrical output of 4 MWe;
Technical data:[d)]	***Dry cogeneration for DTD*** electrical output 3.5 MW_e heat output 10.5 MW_t consumption of NG 3923 thous.Nm^3/a consumption of wood waste 1168 t/a efficiency 30 % electricity production 22750 MWh/a heat production 195800 GJ/a
	Combined Cycles electricity output 3.0 MW_e heat output 10 MW_t consumption of NG 589 thous.Nm^3/a consumption of wood waste -gas turbine 108.4 TJ/a -steam turbine 302.0 TJ/a efficiency 47 % electricity production 16500 MWh/a heat production 198000 GJ/a
	Dry cogeneration for OSB electricity output 4.0 MWe

	efficiency 30 % electricity production 28000 MWh/a consumption of NG 11153 Nm^3/a consumption of wood waste 3735 t/a

Costs

Item	*Project 6.5.2.1.*	*Project 6.5.2.2.*	*Project 6.5.2.3.*
Start Investment Cost of the project in USD	366 846	1 168 405	14 059 027
Maintenance cost in USD/ year	499	4 887	58 807
Operation cost in USD/ year	39 868	350 600	3 359 763
Total cost in USD/20 years	***1 164 196***	***8 180 491***	***81 254 279***
AIJ component in USD/20 years	43 249	400 136	2 861 875
CO_2 avoided (see section E) in tons/a	283	7 537	102 388
USD per avoided ton of CO_2 equivalent	***7.65***	***2.65***	***1.4***

6.5.3 Households

6.5.3.1 Reconstruction of Boiler House in Bytový Podnik Brezno

General information

Item	*Please fill in if applicable*
Type of project:[a)]	Energy efficiency / fuel switching
Location (exact, e.g. city, region, state):	City Brezno ; Slovak Republic
Activity starting date:	technical facilities operative from 1998 or later
Expected activity ending date:	2018
Stage of activity:[b)]	pre-feasibility study
Lifetime of activity if different from ending date:[c)]	2018 or later

JI Project

Item	*Please fill in if applicable*
General description (& acronyms used):	reconstruction of boiler house in Bytový podnik Brezno, fuel switch from brown coal to biomass (wood waste), installation of 3 wood chip boilers
Technical data:[d)]	2 wood waste fired boilers ; power á 0.150 MW_{th} 1 wood waste fired boiler; power 0.045 MW_{th}

	Total power 0.345 MW_{th} Heat production by the installations: 1863 GJ/a

6.5.3.2 Reconstruction of Boiler House Šahy-Sever

General information

Item	*Please fill in if applicable*
Type of project:a)	Energy efficiency / fuel switching
Location (exact, e.g. city, region, state):	City Šahy ; Slovak Republic
Activity starting date:	technical facilities operative from 1999 or later
Expected activity ending date:	2018
Stage of activity:b)	project proposal, implementation of technical facilities in progress
Lifetime of activity if different from ending date:c)	2018 or later

JI Project

Item	*Please fill in if applicable*
General description (& acronyms used):	reconstruction of boiler house in ENERGO-BYTOS Šahy-sever, fuel switch from brown coal to natural gas, installation of 4 gas boilers
Technical data:d)	4 natural gas-fired boilers; power á 1.75 MW_{th} Total power 7 MW_{th} Heat production by the installations: 41 961 GJ/a

6.5.3.3 The Use of Geothermal Potential in Locality Závod

General information

Item	*Please fill in if applicable*
Type of project:a)	fuel switch from natural gas to renewable energy
Location (exact, e.g. city, region, state):	locality Závod; Slovak Republic
Activity starting date:	technical facilities operative from 1999 or later
Expected activity ending date:	2018
Stage of activity:b)	pre-feasibility study
Lifetime of activity if different from ending date:c)	2018 or later

JI Project

Item	*Please fill in if applicable*
General description (& acronyms used):	-replacement of part of heat generated for warm-water supply from existing boiler houses by the geothermal energy. Hot water will be supplied for the local office, elementary school and residential building in locality Závod -the central system of warm-water supplying in locality Závod will be composed from the geothermal supply stations and warm-water distribution system.
Technical data:[d)]	-Geothermal heat generation is based on a system in which the water is pumped through an existing bore (from NG drilling) to a depth of 3000-4000 m. In this bore, the water is heated to 60°C and brings the heat to the heat exchanger on the surface. The additional heat supply is based on the existing warm-water supply system. -The proposed first stage is based on a bore that allows the thermal capacity of 0.376 - 2.3 MW_{th} and enables a yearly production of 16 840 GJ to offset supply from the existing boiler houses. -the capacity of one bore has been estimated at the level of 3 to 10 l/s at the temperature 60°C.

Costs

Item	*Project 6.5.3.1*	*Project 6.5.3.2*	*Project 6.5.3.3*
Start Investment Cost of the project in USD	89 934	395 388	667 660
Maintenance cost in USD/ year	376	1 477	2 793
Operation cost in USD/ year	138 343	87 185	9 974
Total cost in USD/20 years	***228 276***	***2 139 089***	***867 142***
AIJ component in USD/20 years	16 389	166 577	61 555
CO_2 avoided (see section E) in tons/a	372	3 408	1 128
USD per avoided ton of CO_2 equivalent	***2.20***	***2.44***	***2.73***

6.5.4. Summary of JI projects

Item	*sum*
Number of JI projects	***7***
Start Investment Cost of the projects in USD	65 897 782
AIJ component in USD/20 years	25 305 883
CO_2 avoided (see section E) in tons/20 years	7 378 500
USD per avoided ton of CO_2 equivalent (average)	***3.43***

6.6 *Addresses*

6.6.1 *List of Contributors*

This Chapter has elaborated on the framework presented in the Slovak Study on National Strategy for GHG Emission Reduction (GHG Offset Trading Issues). Contributors include

- Ján Judák and Juraj Balajka, Profing s.r.o. Bratislava
- Alexander Lüchinger and Urs Brodmann, Ernst Basler and Partners, Zurich

6.7 References

Carter, Lisa, 1997. *Modalities for the Operationalization of Additionality*. Paper presented at the UNEP/German Federal Ministry of the Environment International Workshop on Activities Implemented Jointly; Leipzig, Germany. E-mail: carter.lisa@epamail.epa.gov

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6.8 *Uniform Reporting Format for AIJ Under the Pilot Phase*

Title

Uniform Format for Prequalification Phase of JI Projects under the Pilot Phase
The text below is reproduced from Annex III to document FCCC/SBSTA/1997/4 (*Report of the Subsidiary Body for Scientific and Technological Advice on the work of its fifth session, Bonn, 25-28 February 1997).*

The uniform reporting format contained below is to be used in reporting on activities implemented jointly under the pilot phase. It is noted that the reporting should be consistent with decision 5/CP.1 and 8/CP.2 (reproduced in annexes I and II to the reporting format which will be made available). The SBSTA notes that the uniform reporting format could possibly require revision in the light of experience gained and methodological work conducted under the pilot phase.

A Description of project

Note: The following figures are draft values intended for demonstration purposes. Preciser figures will be worked out during an in-depth review of the AIJ aspects of the project.

A.1 Project category

.....

A.2 Participants/actors

A.2.1 Authorities

Item	*Please fill in if applicable*
Name of organisation):	
Name of organisation (English):	
Department:	
Acronym:	
Acronym (English):	
Function within activity:	
Street:	
Post code:	
City:	
Country:	
Telephone:	
Fax:	
E-mail:	
Contact person (for this activity):	
Surname:	
First name, middle name:	
Job title:	

Direct Tel:	
Direct fax:	
Direct E-mail:	

a) Organisation includes: institutions, ministries, companies, non-governmental organisations, etc. involved in the activity, i.e. research institutes associated with the project, auditors, government agency closely following the activity.

A.2.2 Project owner

Item	*Please fill in if applicable*
Name of organisation:	
Function within activity:	
Street:	
Post code:	
City:	
Country:	
Telephone:	
Fax:	
Contact person (for this activity):	
Surname:	
First name, middle name:	
Job title:	

A.2.3. National consultant

Item	*Please fill in if applicable*
Name of organisation:	
Name of organisation (English):	
Acronym:	
Acronym (English):	
Function within activity:	
Street:	
Post code:	
City:	
Country:	
Telephone:	
Fax:	
E-mail:	
Contact person (for this activity):	
Surname:	
First name, middle name:	
Job title:	
Direct Tel:	

A.2.4. International Consultant

Item	*Please fill in if applicable*
Name of organisation:	
Name of organisation (English):	Ernst Basler + Partners Ltd.
Department:	Energy and Environmental Planning
Acronym:	EBP
Acronym (English):	EBP
Function within activity:	Consulting engineers, feasibility studies
Street:	Mühlebachstrasse 11
Post code:	8032
City:	Zürich
Country:	Switzerland
Telephone:	+41 1 395 16 16
Fax:	+41 1 395 16 17
E-mail:	alexander.luechinger@ebp.ch
WWW-URL:	
Contact person (for this activity):	------------------------------------
Surname:	Lüchinger
First name, middle name:	Alexander
Job title:	Director
Direct Tel:	+41 1 395 16 53

A.3 *Activity:*

A.3.1. General information

Item	*Please fill in if applicable*
Type of project:[a)]	
Location (exact, e.g. city, region, state):	
Activity starting date:	
Expected activity ending date:	
Stage of activity:[b)]	
Lifetime of activity if different from ending date:[c)]	

A.3.2.Baseline project

Item	*Please fill in if applicable*
General description (& acronyms used):	
Technical data:[d)]	

A.3.3 JI Project

Item	*Please fill in if applicable*
General description (& acronyms used):	
Technical data:[d)]	

a) For example, using Intergovernmental Panel on Climate Change (IPCC) classification: energy efficiency; renewable energy; fuel switching; forest preservation, restoration or reforestation; afforestation; fugitive gas capture; industrial processes; solvents; agriculture; waste disposal or bunker fuels.

b) Circle the appropriate option.

c) Methodological work will be required to define lifetime of activities.

d) Methodological work will be required to determine for each type of activity what the minimum data requirements are.

A.4 Cost (to the extent possible).

Describe briefly how costs are determined:

Note: Indicated baseline costs and CO_2 abatement costs are draft values! ....

A.4.1 Baseline project

Item	***total***
Investment Cost of the project in USD/20 years	
Maintenance cost in USD/20 years	
Total Operation cost O&M USD/20 years	
Total cost in USD/20 years	

Describe briefly how costs are determined:

• ***Baseline cost:*** ..... • • •

A.4.2 JI project

Item	***total***
Start Investment Cost of the project in USD	
Maintenance cost in USD/ year	
Operation cost in USD/ year	
Total cost in USD/20 years	
AIJ component in USD/20 years	
CO_2 avoided (see section E) in tons/a	
USD per avoided ton of CO_2 equivalent	

Describe briefly how costs are determined:

• ***<u>Project cost</u>:*** • **......** • • •

A.5 Additionality assessment

....

A.6 Other barriers

Capital costs **-** ....

Performance risks - ....

Environmental risks ....

Construction risks - ……

Fuel supply security - ....

Operational issues - ....

Power sales risks - ....

A.7 Mutually agreed assessment procedures:

to by filled out during the feasibility study (qualification phase)

B Governmental acceptance, approval or endorsement

to by filled out during the feasibility study (qualification phase)

C Compatibility with and supportiveness of national economic development and socio-economic and environment priorities and strategies

Describe (to the extent possible) how the activity is compatible with and supportive of national economic development and socio-economic and environment priorities and strategies
....

D Benefits derived from the activities implemented jointly project

Whenever possible, quantitative information should be provided. Failing that, a qualitative description should be given. If quantitative information becomes available, it could be submitted using the update(s). (If the amount of quantitative information is too large, the source could be indicated.)

Item	*Please fill in*
Describe environmental benefits in detail:	
Do quantitative data exist for evaluation of environmental benefits?	
Describe social/cultural benefits in detail:	
Do quantitative data exist for evaluation of social benefits?	
Describe economic benefits in detail:	
Do quantitative data exist for evaluation of economic benefits?	

1) UCPTE= European Union pour la co-ordination de la production et du transport de l'éléctricité;

Summary table D1: Projected reductions in fossil fuel consumption and air pollutant emissions

	Fuel consumption MWh/a	NOx t/a	SO_2 t/a	VOC t/a	CO t/a	Dust t/a
A) Baseline						
B) Project						
C) Total effect (B-A)						

E Calculation of the contribution of activities implemented jointly projects that bring about real, measurable and long-term environmental benefits related to the mitigation of climate change that would not have occurred in the absence of such activities

E.1 Estimated emissions without the activity (project baseline):

....

E.2 Estimated emissions with the activity:

....

Summary table E1: Projected emission reductions by the geothermal energy using project

	GHG	Year 1 (1999)	Year 2 (2000)	Years 3-19 (2001-2017)	Year 20 (2018)
A) Project baseline scenario	CO_2				
	CH_4				
	N_2O				
	other				
B) Project activity scenario	CO_2				
	CH_4				
	N_2O				
	other				
C) Effect (B-A)	CO_2				
	CH_4				
	N_2O				
	other				
D) Cumulative effect	CO_2				
	CH_4				
	N_2O				
	other				

Summary table: Actual emission reductions

F Bearing in mind that the financing of activities implemented jointly shall be additional to financial obligations of Parties included in Annex II to the Convention within the framework of the financial mechanism as well as to current official development assistance flows, please indicate:

....

Contribution to capacity building, transfer of environmentally sound technologies and know-how to other Parties, particularly developing country Parties, to enable them to implement the provisions of the Convention. In this process, the developed country Parties shall support the development and enhancement of endogenous capacities and technologies of developing country Parties.

H Additional comments, if any, including any practical experience gained or technical difficulties, effects, impacts or other obstacles encountered.

A P P E N D I X 1

UN FCCC, Article 3:

To achieve the objective of the Convention and to implement its provisions the Parties are guided by following five principles (Article 3):

- The Parties should protect the climate system on the basis of equity and in accordance with their common but differentiated responsibilities and respective capabilities;
- The specific needs and special circumstances of developing country Parties should be given full consideration;
- The Parties should take precautionary measures to anticipate, prevent or minimise the causes of climate change and mitigate its adverse effects;
- The Parties have a right to, and should, promote sustainable development. Policies and measures to protect climate system against human-induced change should be appropriate for the specific conditions of each Party and should be integrated with national development programmes;
- The Parties should co-operate to promote a supportive and open economic system that would lead to sustainable economic growth and development;

Excerpts from FCCC/CP/1997/L.7/Add.1 *(10 December 1997, subject to technical revision)* regarding joint implementation, the clean development mechanism and emissions trading

Article 6 (Joint Implementation)

1. For the purpose of meeting its commitments under Article 3, any Party included in Annex I may transfer to, or acquire from, any other such Party emission reduction units resulting from projects aimed at reducing anthropogenic emissions by sources or enhancing anthropogenic removals by sinks of greenhouse gases in any sector of the economy, provided that:
   (a) Any such project has the approval of the Parties involved;
   (b) Any such project provides a reduction in emissions by sources, or an enhancement of removals by sinks, that is additional to any that would otherwise occur;
   (c) It does not acquire any emission reduction units if it is not in compliance with its obligations under Articles 5 and 7; and
   (d) The acquisition of emission reduction units shall be supplemental to domestic actions for the purposes of meeting commitments under Article 3.

2. The Conference of the Parties serving as the meeting of the Parties to this Protocol may, at its first session or as soon as practicable thereafter, further elaborate guidelines for the implementation of this Article, including for verification and reporting.
3. A Party included in Annex I may authorise legal entities to participate, under its responsibility, in actions leading to the generation, transfer or acquisition under this Article of emission reduction units.

4. If a question of implementation by a Party included in Annex I of the requirements referred to in this paragraph is identified in accordance with the relevant provisions of Article 8, transfers and acquisitions of emission reduction units may continue to be made after the question has been identified, provided that any such units may not be used by a Party to meet its commitments under Article 3 until any issue of compliance is resolved.

Article 12 (Clean Development Mechanism)

1. A clean development mechanism is hereby defined.

2. The purpose of the clean development mechanism shall be to assist Parties not included in Annex I in achieving sustainable development and in contributing to the ultimate objective of the Convention, and to assist Parties included in Annex I in achieving compliance with their quantified emission limitation and reduction commitments under Article 3.

3. Under the clean development mechanism:
   (a) Parties not included in Annex I will benefit from project activities resulting in certified emission reductions; and
   (b) Parties included in Annex I may use the certified emission reductions accruing from such project activities to contribute to compliance with part of their quantified emission limitation and reduction commitments under Article 3, as determined by the Conference of the Parties serving as the meeting of the Parties to this Protocol.

4. The clean development mechanism shall be subject to the authority and guidance of the Conference of the Parties serving as the meeting of the Parties to this Protocol and be supervised by an executive board of the clean development mechanism.

5. Emission reductions resulting from each project activity shall be certified by operational entities to be designated by the Conference of the Parties serving as the meeting of the Parties to this Protocol, on the basis of:
   (a) Voluntary participation approved by each Party involved;
   (b) Real, measurable, and long-term benefits related to the mitigation of climate change; and
   (c) Reductions in emissions that are additional to any that would occur in the absence of the certified project activity.

6. The clean development mechanism shall assist in arranging funding of certified project activities as necessary.

7. The Conference of the Parties serving as the meeting of the Parties to this Protocol shall, at its first session, elaborate modalities and procedures with the objective of ensuring transparency, efficiency and accountability through independent auditing and verification of project activities.

8. The Conference of the Parties serving as the meeting of the Parties to this Protocol shall ensure that a share of the proceeds from certified project activities is used to cover administrative expenses as well as to assist developing country Parties that are particularly vulnerable to the adverse effects of climate change to meet the costs of adaptation.

9. Participation under the clean development mechanism, including in activities mentioned in paragraph 3(a) above and acquisition of certified emission reductions, may involve private and/or public entities, and is to be subject to whatever guidance may be provided by the executive board of the clean development mechanism.

10. Certified emission reductions obtained during the period from the year 2000 up to the beginning of the first commitment period can be used to assist in achieving compliance in the first commitment period.

Article 17 (Emission Trading)

The Conference of the Parties shall define the relevant principles, modalities, rules and guidelines, in particular for verification, reporting and accountability for emissions trading.

The Parties included in Annex B may participate in emissions trading for the purposes of fulfilling their commitments under Article 3 of this Protocol. Any such trading shall be supplemental to domestic actions for the purpose of meeting quantified emission limitation and reduction commitments under that Article.

Decisions on AIJ, COP-1,Decision 5/cp.1

COP-1 reached a decision on "activities implemented jointly under the pilot phase" (FCCC/CP/1995/7/Add.1, decision 5/CP.1). The Conference decided that a framework for reporting on AIJ under the pilot phase should be established by the Subsidiary Body for Scientific and Technological Advice (SBSTA), in coordination with the Subsidiary Body for Implementation (SBI).

This framework should report in a transparent, well-defined and credible fashion on the possible global benefits and the national economic, social and environmental impacts as well as any practical experience gained or technical difficulties encountered. It specifies that non-Annex I Parties can participate in such activities when they so request.

The COP-1 decision on AIJ under the pilot phase specified that:

- non-Annex I countries have no commitments under Article 4.2(a) of the Convention;
- AIJ between Annex I and non-Annex I countries will not be seen as fulfilment of current commitments of Annex I Parties under Article 4.2(b) of the Convention but could contribute to the achievement of the objective of the Convention and to fulfilment of commitments of Annex I Parties under Article 4.5 of the Convention;
- the financing of AIJ shall be additional to the financial obligations of developed country Parties;
- AIJ should be treated as a subsidiary means of achieving the objective of the Convention, and
- AIJ does not modify the commitments of each Party under the Convention.

The COP-1 decision also laid out the following criteria for AIJ projects:

- AIJ should be compatible with and supportive of national environment and development priorities and strategies;
- AIJ should contribute to cost-effectiveness in achieving global benefits;
- AIJ could be conducted in a comprehensive manner covering all relevant sources, sinks and reservoirs of GHG;
- all AIJ require prior acceptance, approval or endorsement by the Governments of the Parties participating in these activities;
- AIJ should generate real, measurable and long-term environmental benefits related to the mitigation of climate change that would not have occurred in the absence of such activities;

Table A1. 1 Differences between allowance trading and credit trading[29]

ITEM	*ALLOWANCE TRADING*	*CREDIT TRADING*
Commodity	Allowances(permits)	Credits(offsets)
Property right	Use of atmosphere(budget)	Only credits
Compliance	Based on emission inventories	Based on project monitoring
Institutions	International market	Ad hoc trades approved by governments
Reference	National cap	Project baseline
Emission monitoring	National inventories	Project emissions
Incentive for seller/host	Revenues to national budget(environmental fund)	Revenues to project

Incentive for buyer/investor	Lower abatement costs	Lower abatement cost
Implementation of reductions	Policy instruments	Direct technology investment
Transaction costs	Low	Possibly high
National implementation cost	Possibly high	Low
Reduction potential	Large	Limited
Time horizon	After 2010	About 2000
Development	International market construction as a whole	Gradual evolution of market

Source: A National Strategy for JI in the Czech Republic, Prague, Base l, Zollikon ,Zurich, November 1997

A P P E N D I X 2

In this appendix all input data, applied assumptions and adopted sensitivity analysis are reviewed. Analyses in this part enable us to take in more details approaches used at scenario modelling and sensitivity analyses needed for baseline scenario selection. All these data serve as an input for additional analysis of emission credit and/or allowance trading possibility in SR.

Methodology And Input Data

Methodology And Sectoral Split Of Energy Flowsheet

Energy related emissions EM of CO_2 are determined by fuel consumption FC and emission factor EF_{CO_2}[1]:

$$EM\ [t\ CO_2/year] = \Sigma FC\ [TJ/year] \times EF_{CO_2}\ [t\ CO_2/TJ]$$

Fuel consumption FC is related to the energy demand, required fuel mix, technological and economical environment. Generally, the consumption of individual fuel type can be expressed as the function of following variables, interacting to each other.:

$$FC = f\ (DEMAND, \text{fuel mix, technology used, efficiency, costs, price regulation})$$

Several types of models are available to solve the problem, such as MARKAL, ENPEP/BALANCE, MEDE, etc. On the base of previous activities and experiences (Co-operation in preparing Country Study Slovakia 1997, The Second National Communication on Climate Change 1997, etc.) the BALANCE module of ENPEP software package has been used.
Modules of BALANCE package enable us to simulate energy balance in selected period [2,3]. A following input data are needful for this module application:

1) Flowsheet of energy sector in total
2) Energy balance for first year of study (selected one) ;
3) Annual growth rate of individual energy demand streams for selected study period;
4) Fuel & energy prices and their escalation;
5) Investment costs of new arrangements;
6) Technical data of individual energy nodes (efficiency or heat rates, capacities and expansion plan of energy conversion units, time of retirement, fuel mix at technological uses, etc.);

As a first year of study has been selected the year 1995. Fuel consumption for this year was given by Energy statistics of Slovakia[6] for the year 1995. On the base of demand of j-th energy stream in i-th year, the energy demand for next year is given as:

$$DEMAND_{j,i+1} = AGR_{j,i+1} \times DEMAND_{j,i}$$

where an annual growth rate AGR can be expressed as follows:

$$AGR = \frac{\Delta DEMAND}{DEMAND}$$

This annual growth rate represents one of the most important input data for the BALANCE module[5] and usually can be obtained from the activity data of particular sector.

The relationship between the sectoral activity and appropriate final energy demand can be expressed by use of elasticity factor [9]:

$$e = \frac{\Delta Demand/Demand}{\Delta activity/activity} \leq 1$$

The elasticity factor is influenced by sectoral energy intensity, by the switch of final energy demand mix and by sectoral restructuring. Usually, in countries with stable economic development, this factor can be fixed using historical data[9]. In contrast with this, determination of elasticity factor in countries with economy in transition is connected with the problems that we have already discussed in Chapter 1 and 2. Considering the actual situation in the Slovak Republic, energy flowsheet has been disaggregated into followed sectors participating in energy conversion process :

I. Electricity supply system
II. District heating supply
- regional energy utilities SSEZ and ZSE
- local heating plants

III. Industry
- direct use of fuels in technologies
- fuel use in industrial

IV. Services & commercial sector
V. Residential sector
VI. Transportation sector

In framework of national and international energy statistics for residential sector is included the fuel consumption for the local district heat supply facilities. The thermal capacity of these sources is higher than 5 MWt and will be influenced by the new environmental legislation. The same situation is in case of commercial & services. In our flowsheet, these sectors were treated separately, using the detailed data base of individual boilers with all needed parameters. Transportation sector represents the use of fuel in road, rail, water and air transport.

Energy demand in industry consists of:

I. Direct fuel use at steel production
II. Direct fuel use in other industrial technologies (feedstock, process heating, etc.)
III. Electricity and heat (hot water & steam) at steel production
IV. Electricity and heat (hot water & steam) in other industry

Demands on electricity are split into following sectors:

I. Metallurgy/steel production
II. Other industrial uses
III. Residential area
IV. Services
V. Commercial
VI. Transportation
VII. Electric heating
VIII. Other uses

Electricity and heat in industrial sector should be supplied from industrial CHP (combined heat and power plant), grid (electricity) and external centralised heat supply (usually hot water).

Macroeconomic Indicators During Period Of Transition To A Market Economy In SR[7]

The macroeconomic indicators determine the main share of final energy consumption. The projection of their development in period of transition to a market economy is more difficult than for developed countries with stable economics. Each year of transformation is characterised by significant specific features of economic development in Slovakia:

1993 - the year in which the economic parameters for new created independent state were "adjusted";

1994 - the first year with economic growth that was completely raised by external demands;

1995 - economic growth has continued. Growth of revenues supported domestic demands as well as accelerated import. The domestic demands became the main determinant of growth. In spite of this, impact of external demands remained considerable;

1996 - in this year there was characteristic the dominant position of domestic impact including investment demands with decreasing influence of external demands. Economics was able to achieve the growth only by increasing import of goods and services. That was a consequence of increasing GDP intensity for intermediate consumption as well as of financial position of companies and households that enabled higher import comparing with the previous year.
On the other side, this development was connected with almost exhausted existing export capacities and slow generation of new ones resulting in inadequate growth of export efficiency of economics. This status is affected by decreasing effectiveness of objective economic processes resulting from insufficient microeconomic adaptation and small share of efficient structural changes. The development of export performance level was also influenced by lower than expected economic growth on side of our main trade partners.

1997 - Economics of the Slovak Republic started in the year 1997 with one of the best macroeconomics results among other countries with economy in transition (EIT). Achieved rate of inflation in SR for the year 1997 was higher than one in previous year, nevertheless still lower than the same value for our neighbouring EIT countries. Recorded economic growth in 1997 was lower comparing with the year 1996, but still belonged to the highest one in this region. The lowest inflation rate among the EIT countries of middle Europe and economic growth better adopted to the possibilities of national economy are supposed to be one of the most considerable results of Slovak economics in last year. This success has been achieved mainly due to conservation of national exchange stability as well as decreasing deficiency of foreign trade relations. This is above all result of currency policy of the National bank of Slovakia and effect of governmental administrative tools to protect domestic trade. This result is more valued in view of its achievement in conditions of increasing deficiency of national budget. The share of balance of payment current account deficiency on GDP decreased from 11.1 % level in 1996 under 8 % in 1997.

Table A2 1. Basic macroeconomics indicators in the Slovak Republic[7]

	1993	***1994***	***1995***	***1996***	***1997*** [*1]
GDP (comparable prices, annual growth rate)	-3.7	4.9	6.8	6.9	5.9
Rate of inflation (%)	25.1	11.7	7.2	5.4	6.4
Rate of unemployment (%)	12.7	14.6	13.8	12.6	12.8
National budget deficiency in % of GDP (nominally)	-6.2	-5.2	-1.6	-4.4	-5.9
Share of current account deficiency for balance of payment	-5.0	+4.8	+2.3	-11.1	-7.7

on GDP (%)					

**1 forecast*

Source: P.Karasz-Forecast of selected macroeconomic indicators of Slovak economics, Part 2.;Economic Consulting,Bratislava 1998

Even though the adjustment of growth rate dynamic to limitations of economics was better in the year 1997, outlasted import intensity and low export efficiency represents also in this year one of basic structural-performance unbalances of Slovak economics.
This structural-performance unbalance is closely related to the unbalanced economics from existing industrial capacity point of view. On one side there is a material and energy intensive structure of these capacities with high requirements to the raw material and energy sources imported, but, on the other side, the share of their potential production is multiplex to the absorptive characteristics of market. The part of capacities has been built for markets that already do not exist at present .

The development up to now indicates that industry in economic conditions of SR is still the branch with the highest dynamism. That means the industry plays always the main role in process of solution structural-performance achievement unbalance as well as further formation of GDP creation structure.
That's the reason why forecast rises from renewal of trends appointed in Industrial policy of the Slovak Republic.

Development of these tendencies shows that decisive role of industry will be concentrated primarily on:

- growth of national economy efficiency;
- decrease of production demands to the intermediate consumption;
- growth of export efficiency;

During the process of following the best way to meet these targets we should remember high material intensity of Slovak industry as well as disproportion resulting from the situation before the year 1993 characterised by deep under-dimensioned sector of services which doesn't permit sufficient operating of material production and is decreasing its effectiveness and competitiveness.
That means the key points of successful structural changes of Slovak economics will be mainly:

- character of development the share of industry to the GDP creation;
- movement of service development ;

Prediction rises from such formation of Slovak economics structure, that will be in period 1998 - 2010 characterised primarily with:

- decreasing share of agriculture on the GDP creation;
- decreasing share of industry production on the GDP creation;
- oscillating share of building on the GDP creation about the level achieved in 1997;
- increasing share of market services on the GDP creation;
- increasing share of non-market service;

Forecast has been elaborated in two variants for high and low GDP development. The characteristics of movement this development are summarised in Table A2 2.

Table A2 2. Development of feasible GDP creation in Slovak economics[7]

	1993-1996	***1997-2000***	***2001-2010***
Average annual growth rate in %	6.3	4.4 - 5.7	3.7-5.4

Source: P.Karasz-Forecast of selected macroeconomic indicators of Slovak economics, Part 2.;Economic Consulting,Bratislava 1998

There can be stated, that lower movement of external demands and slow decreasing of structural rebuilding will press dynamics down to the lower border and, on the contrary, higher dynamics of external demands and faster process of structural rebuilding based on effective investments' allocating will push growth dynamics to the upper border of interval. These borders are determined in view of formation the sectoral structure of GDP creation under development that can be characterised as follow:

Slow decrease of agriculture share on the GDP creation in case of lower border and, on the contrary, faster decrease of this share in case of upper border of GDP development.
In case of lower border of GDP development there is typical decreased share of industry on the GDP creation, so the internal structural changes are going slowly. A development is impacted by considerable persistence of economic processes operation. Share of material intensive sectors on the GDP creation is decreasing slowly. Shaping of adequate ratio for capital and consumer goods in frame of machinery is also proceeded very slowly.

The development persistence is typical also for rate of increasing the share of manufacturing industry on the industry production.
For upper level of GDP development is characteristic such decrease of industry share on the GDP creation, where the internal structural changes in industry go on faster than it would be typical for development resulting from upper level of GDP.

The development for the material intensive sectors is influenced mainly by decreasing share of manufacture of basic metals and fabricated metal products on the GDP creation. Result of structural changes in machinery industry is gradual conversion of ratio the investment to consumer goods. Step by step is increasing , namely after the year 2000, the share of manufacturing industry on the industry production.

There is evident less intensive growth of services share to the GDP creation in case of lower level and, in the contrary, faster growth of this ratio in case of upper level for GDP development. In case of faster growth of services' share on the GDP creation there is uppermost the growth of market services that are above all related to the operation of material production.

Characteristics of basic proportions for described structural development are summarised in Table A2 3.

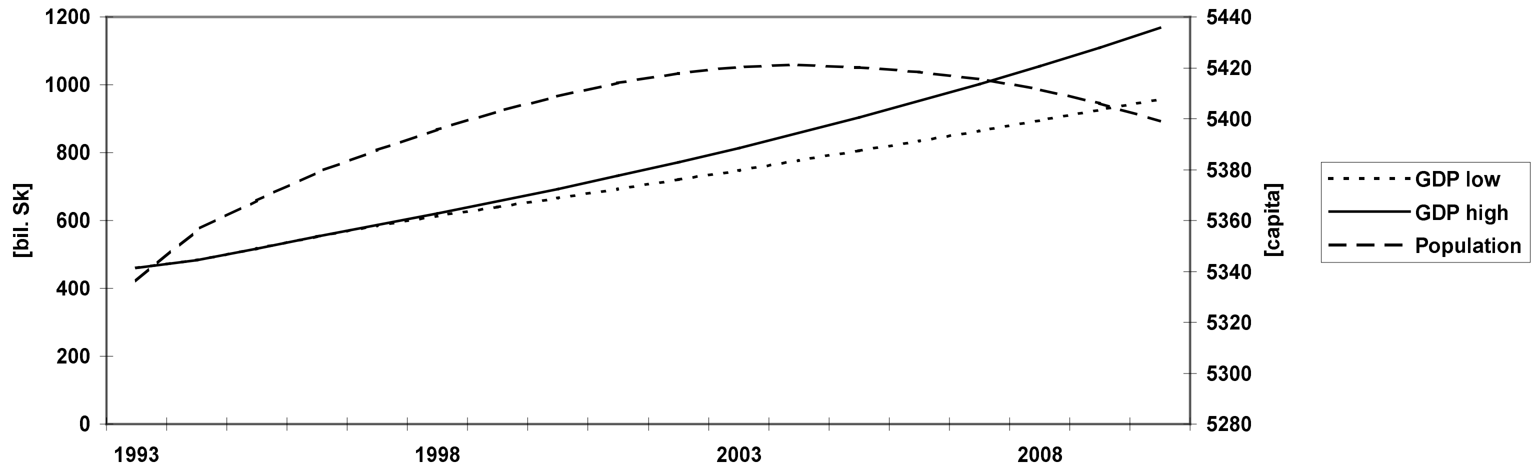
Table A2 3. Sectoral structure of GDP creation in %
(constant prices December 1995 =100)[7]

Sector	*1995*	*2000*		*2010*	
		Lower level	*Upper level*	*Lower level*	*Upper level*
Agriculture	5.3	4.8	4.6	3.9	3.3
Industry in total	28.7	25.7	23.8	21.7	21.3
Building	4.8	4.2	4.2	3.8	3.7
Services	53.4	56.7	59.9	62.1	66.6
Other	7.8	8.5	7.5	8.5	5.1
Economy in total	100.0	100.0	100.0	100.0	100.0

Source: P.Karasz-Forecast of selected macroeconomic indicators of Slovak economics, Part 2.;Economic Consulting,Bratislava 1998

In next tables are given data of GDP creation scenarios for selected study period disaggregated by main sectors. A comparison of total GDP and population development is given in Figure A2 1. and Table A2 4.

Figure A2 1. Main macroeconomic scenarios for period 1993 - 2010[7]



Source: P.Karasz-Forecast of selected macroeconomic indicators of Slovak economics, Part 1.;Economic Consulting,Bratislava 1998

Table A2 4. Main macroeconomic scenarios for period 1993 - 2010 [bil.Sk] [7]

	1993	***1994***	***1995***	***1996***	***1997***	***1998***	***1999***	***2000***	***2001***	***2002***	***2003***	***2004***	***2005***	***2006***	***2007***	***2008***	***2009***	***2010***
GDP low	460.8	483.6	517.2	553.1	585.0	612.5	639.4	666.3	693.0	720.7	748.1	776.5	805.2	834.2	864.2	894.5	925.8	957.3
GDP high	460.8	483.6	517.2	553.1	586.4	620.4	655.8	692.5	731.3	771.5	813.9	857.9	904.2	952.1	1002.6	1054.7	1109.6	1167.3
Population [thous.]	5336.5	5356.2	5367.8	5378.9	5387.8	5395.8	5402.9	5408.7	5414.0	5418.0	5420.4	5421.2	5420.2	5418.4	5415.6	5411.5	5406.0	5399.0

Table A2 5. GDP in SR, low scenario [bill. Sk],constant prices 1995 = 100%

	1995	***1996***	***1997***	***1998***	***1999***	***2000***	***2001***	***2002***	***2003***	***2004***	***2005***	***2006***	***2007***	***2008***	***2009***	***2010***
Agriculture	27.6	28.6	29.9	30.9	31.7	32.3	32.7	32.9	33.1	33.2	33.4	33.7	34.9	36.0	37.2	37.7
Industry total	148.5	148.7	156.1	161.8	166.8	171.1	174.6	177.6	180.2	182.7	185.4	188.3	191.7	197.1	201.5	208.0
Industry split																
Mining	4.8	5.8	6.2	6.5	6.7	6.8	7.0	7.1	7.2	7.3	7.4	7.5	7.7	7.9	8.1	8.3
Food production	14.9	15.9	16.8	17.5	18.2	18.7	19.2	19.7	20.1	20.5	20.9	21.4	21.9	22.6	23.3	24.2
Chemistry and oil refinery	22.5	20.3	21.2	22.0	22.6	23.1	23.5	23.8	24.1	24.4	24.6	24.9	25.3	26.0	26.5	27.2
Metallurgy and metal processing	20.0	19.5	20.1	20.4	20.6	20.7	20.8	20.8	20.8	20.8	20.8	20.9	20.9	21.2	21.4	21.8
Machinery and electric appliances production	25.2	27.3	29.4	31.2	33.0	34.7	35.9	37.2	38.3	39.1	40.0	41.0	42.1	43.6	44.9	46.7
Electricity and gas supply utilities	22.0	23.2	24.5	25.5	26.4	27.2	27.9	28.5	28.9	29.4	29.9	30.4	31.0	32.0	32.8	33.9
Other industrial branches	39.1	36.7	37.9	38.8	39.4	39.8	40.2	40.5	40.7	41.2	41.7	42.2	42.8	43.8	44.6	45.9
Construction	24.6	24.7	26.3	27.0	27.6	28.1	28.7	29.2	29.8	30.5	31.2	31.9	33.0	34.0	35.2	36.4
Services & commercial	276.3	303.4	322.9	340.7	358.9	378.1	398.2	419.6	441.5	464.2	487.0	509.5	530.9	551.2	572.7	594.1
Other	40.2	47.7	49.7	52.1	54.4	56.7	58.9	61.2	63.5	65.9	68.3	70.7	73.8	76.1	79.1	81.1
Total	***517.2***	***553.1***	***585.0***	***612.5***	***639.4***	***666.3***	***693.0***	***720.7***	***748.1***	***776.5***	***805.2***	***834.2***	***864.2***	***894.5***	***925.8***	***957.3***

Source: P.Karasz-Forecast of selected macroeconomic indicators of Slovak economics, Part 1.;Economic Consulting,Bratislava 1998

Table A2 6. GDP in SR, high scenario [bill. Sk],constant prices 1995 = 100%

	1995	***1996***	***1997***	***1998***	***1999***	***2000***	***2001***	***2002***	***2003***	***2004***	***2005***	***2006***	***2007***	***2008***	***2009***	***2010***
Agriculture	27.6	28.6	29.9	30.7	31.3	31.8	32.1	32.3	32.3	32.1	32.6	33.6	34.1	35.9	37.7	38.5
Industry total	148.5	148.7	156.6	158.8	161.5	164.9	169.7	175.7	183.2	192.0	201.9	212.8	218.6	227.8	237.5	248.6
Industry split																
Mining	4.8	5.8	6.3	6.4	6.5	6.6	6.8	7.0	7.3	7.7	8.1	8.5	8.7	9.1	9.5	9.9
Food production	14.9	15.9	16.8	17.2	17.6	18.1	18.7	19.5	20.4	21.5	22.8	24.2	25.0	26.2	27.4	28.9
Chemistry and oil refinery	22.5	20.3	21.3	21.5	21.9	22.2	22.8	23.6	24.5	25.6	26.8	28.2	28.9	30.0	31.2	32.5
Metallurgy and metal processing	20.0	19.5	20.1	20.0	19.9	19.9	20.2	20.6	21.2	21.9	22.7	23.6	23.9	24.5	25.2	26.0
Machinery and electric appliances production	25.2	27.3	29.5	30.6	31.9	33.4	34.9	36.8	38.9	41.1	43.6	46.3	48.0	50.4	52.9	55.9
Electricity and gas supply utilities	22.0	23.2	24.5	25.0	25.6	26.2	27.1	28.2	29.4	30.9	32.6	34.4	35.4	37.0	38.6	40.5
Other industrial branches	39.1	36.7	38.0	38.1	38.2	38.4	39.1	40.1	41.4	43.3	45.4	47.6	48.8	50.6	52.6	54.8
Construction	24.6	24.7	26.4	27.2	28.0	28.8	29.7	30.7	31.8	33.1	34.5	36.1	37.8	39.6	41.5	43.2
Services & commercial	276.3	303.4	323.7	352.8	383.4	415.0	447.5	480.5	514.6	549.5	585.8	623.3	661.8	697.7	736.1	777.3
Other	40.2	47.7	49.8	51.0	51.6	52.0	52.3	52.3	52.0	51.3	49.4	46.4	50.3	53.7	56.8	59.7
Total	***517.2***	***553.1***	***586.4***	***620.4***	***655.8***	***692.5***	***731.3***	***771.5***	***813.9***	***857.9***	***904.2***	***952.1***	***1002.6***	***1054.7***	***1109.6***	***1167.3***

Source: P.Karasz-Forecast of selected macroeconomic indicators of Slovak economics, Part 1.;Economic Consulting,Bratislava 1998

Fuel Mix And Impact Of New Emission Standards

The present emission standards applied in Slovakia are focused mainly on the acceptable concentration level of air pollutants in gases in stacks. Emission standards of SO_2, NOx, CO and solid particles play the most important role in case of fossil fuel combustion so existing facilities must meet these standards within a strictly defined period (since 31.12.1998). New environmental legislation (see Chapter 4) established the use of BATNEEC for new and retrofitted units and also air pollution charges. In tables A2 7. and A2 8. are summarised emission standards for existing and new energy sources. As an existing energy sources the arrangements committed before the year 1996 have been considered. For sources committed before the Act No. 309/1991 has been adopted, an individual standards and period to meet requirements given in Table A2 7. have been determined. The sources that have been committed in period 1992 - 1996 must meet standards given in Table A2 7. immediately. The sources committed after the year 1996 must satisfy requirements given in Table A2 8. and these requirements will also be obligatory for all sources since the year 2010.

Table A2 7. Emission standards for existing sources

Fuel	*[MWt]*	*unit*	*SO_2*	*NOx*	*CO*	*Solids*
Solid 6%O_2 in flue gases	5 - 50	[mg.Nm-3]	2500	650	250	150
	50-300	[mg.Nm-3]	1700	550	250	100
		ER [%]	60			
	>300	[mg.Nm-3]	500	550	250	100
		ER [%]	15			
	wet bottom	[mg.Nm-3]	as other	1100	250	as other
	Fluid bed	[mg.Nm-3]	400	400	250	100
		ER [%]	15			
Liquid 3%O_2 in flue gases	5 - 50	[mg.Nm-3]	1700	450	175	100
	50-300	[mg.Nm-3]	1700	450	175	50
	>300	[mg.Nm-3]	500	450	175	50
		ER [%]	15			
Gaseous 3%O_2 in FG	NG	[mg.Nm-3]	35	200	100	10
	Refinery gas	[mg.Nm-3]	100	200	100	10
	Metal. gases	[mg.Nm-3]	800	200	100	50
GAS	TURBINES	15% O_2 in FG				
Liquid	<60000m³/h	[mg.Nm-3]	1700	350	100	4°Bararach
	≥60000m³/h	[mg.Nm-3]	1700	300	100	2°Bararach
Gaseous	<60000m³/h	[mg.Nm-3]	-	350	100	4°Bararach
	≥60000m³/h	[mg.Nm-3]	-	300	100	2°Bararach

At simultaneously combustion of several fuels the emission standards are determined by the fuel with the highest thermal input. A concentration is considered in dry gases with the determined oxygen content in flue gases (FG). In the case of wood combustion in boiler, the same standards as in the case of coal are obligatory, the oxygen content is of 11%. To recalculate concentration from measured values we have used the next formula:

$$C_{O2,stand} = C_{O2,measured}\ x(21 - O_{2,stand})/ (21 - O_{2,measured})$$

Emission standards are defined as a concentration ones. For fuels containing sulphur (heavy fuel oils, coals) legislation rule defines also the emission rate ER [%] on which the applied abatement technology is obligatory to reduce emitted amount of SO_2. Relationship between efficiency of abatement technology $\square_{abat}$ and emission rate is as follows:

$$\square_{abat}\ [\%] = 100 - ER\ [\%]$$

Table A2 8. Emission standards for new sources

Fuel	[MWt]	unit	SO_2	Nox	CO	Solids
Solid	5 - 40	[mg.Nm-3]	2500 >10kgSO_2/h	650	250	150
6%O_2 in FG	40-140	[mg.Nm-3]	1700	550	250	100
		ER [%]	60			
	140 - 400	[mg.Nm-3]	2400 - 5 x MWt			
		ER [%]	84-0.185 xMWt			
	>400	[mg.Nm-3]	400	550	250	50
		ER [%]	10			
	wet bottom	[mg.Nm-3]	as other	1100	250	as other
	Fluid bed	[mg.Nm-3]	400	400	250	100
		ER [%]	15			
Liquid 3%O_2 in FG	5 - 50	[mg.Nm-3]	1700	450	175	100
	50-265	[mg.Nm-3]	1700	450	175	50
		ER [%]	10			
	265-435	[mg.Nm-3]	3630-7.425xMWt	450	175	50
		ER [%]	10			
	>435	[mg.Nm-3]	400	450	175	50
		ER [%]	10			
Gaseous 3%O_2 i	NG	[mg.Nm-3]	35	200	100	10
	Refinery gas	[mg.Nm-3]	100	200	100	10
in FG	Metal. gases	[mg.Nm-3]	800	200	100	50
GAS TURBINES						
Liquid	<60000m^3/h	[mg.Nm-3]	1700	350	100	4°Bararach
	≥60000m^3/h	[mg.Nm-3]	1700	300	100	2°Bararach
Gaseous	<60000m^3/h	[mg.Nm-3]	-	350	100	4°Bararach
	≥60000m^3/h	[mg.Nm-3]	-	300	100	2°Bararach

In case of simultaneous combustion of several types of fuel when thermal input of all fuels is lower than 70%, the mixed emission standards are used:

$$ES_{mix,\ O2,ref} = \frac{(20.95 - O_{2,ref})}{Q_{c,input}} \times \sum_{i=1}^{i=n} \frac{Q_i \times ES_i}{(20.95 - O_{2,i})}$$

$ES_{mix,\ O2,ref}$ = mixed emission standard
ES_i = emission standard defined for i-th fuel
$Q_{c,input}$ = total thermal input in fuels
Q_i = thermal input of i-th fuel
$O_{2,ref}$ = oxygen content in FG defined for fuel with higher thermal input
$O_{2,i}$ = oxygen content defined for i-th fuel

Application of emission standards will bring positive impact on technology structure of energy sources and, secondary, on the CO_2 emission level. Impact of different technology measures, that are directly or indirectly connected with implementation of emission standards, is evaluated in following table.

Table A2 9. Impact of energy source repowering or retrofit on the CO_2 emission level

Repowering/ Retrofit	*Characteristics*	*Impact*
Fuel switch coal or oil to gas	Lower EF of NG, increase in thermal efficiency of boiler	Decrease in CO_2 emissions
New gas boiler, source repowering	Increase in efficiency, sometime connected with fuel switch	Decrease in CO_2 emissions
Implementation of combined cycle	Increase in efficiency, sometime connected with fuel switch, decreasing demand on grid electricity or changed fuel mix in electricity supply utility	Impact depends on the total national balance, preferably on type of grid electricity replaced (fossil or non-fossil, import)
Use of biomass, geothermal energy	Same as fuel switch, even at decreased thermal efficiency, positive impact is achieved due to convenient carbon balance	Decrease in CO_2 emissions
Small hydropower plants	Decreased demand on the grid electricity	Positive or zero impact on the CO_2 decrease, depending on the type of grid electricity replaced.
Fluidised bed combustion	Change of fuel mix- the combustion stabilisation is not necessary. Enable us combustion of bad quality fuel with higher EF of CO2	Impact depends on the fuel balance, and decrease or increase of thermal efficiency of process.
Electric heating	Increasing demand on grid electricity	Impact depends on the fuel mix at grid electricity generation

Using the bottom-up analysis of individual energy sources, which covered all energy sources (boilers) with thermal capacity >5 MWt, the share of individual fuels on primary heat production (steam, hot water)has been established [8]. In following figure we illustrate changes of heat rate for individual fuels for primary heat production [TJ fuels/TJ heat]. This ratio is reversible value of efficiency and total decrease in heat rate indicates increase in efficiency.

Figure A2 2. Impact of emission standards on the heat rate of individual fuels in sector of local heating

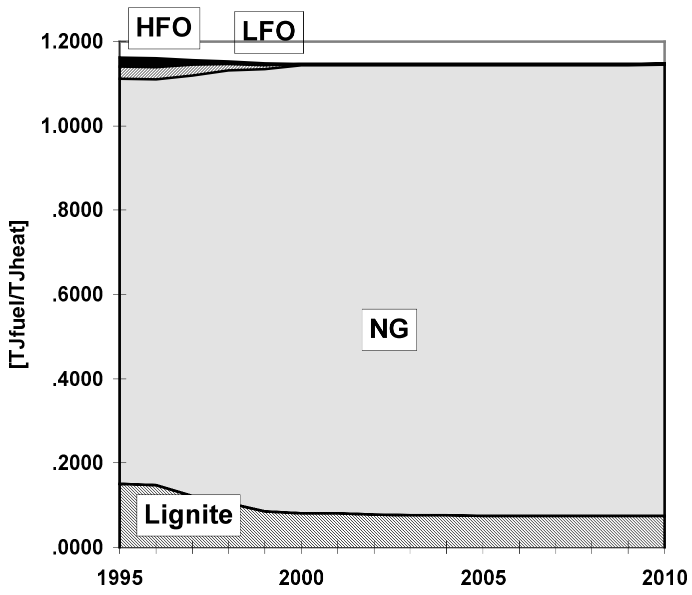


Figure A2 3. Impact of emission standards on the heat rate of individual fuels in industrial boilers

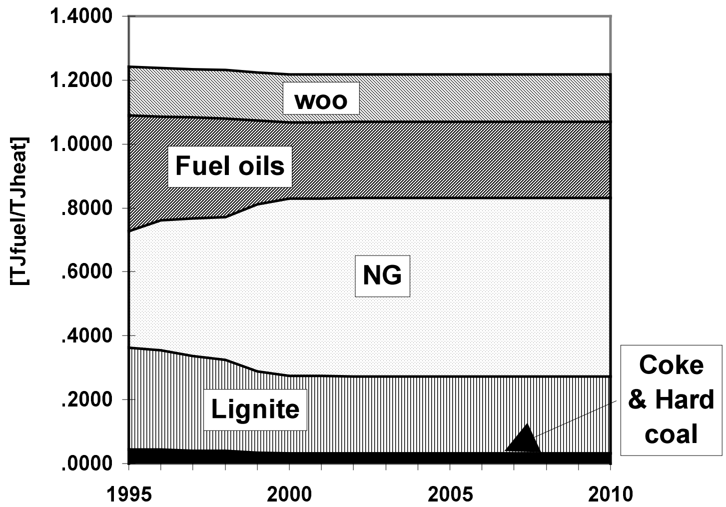
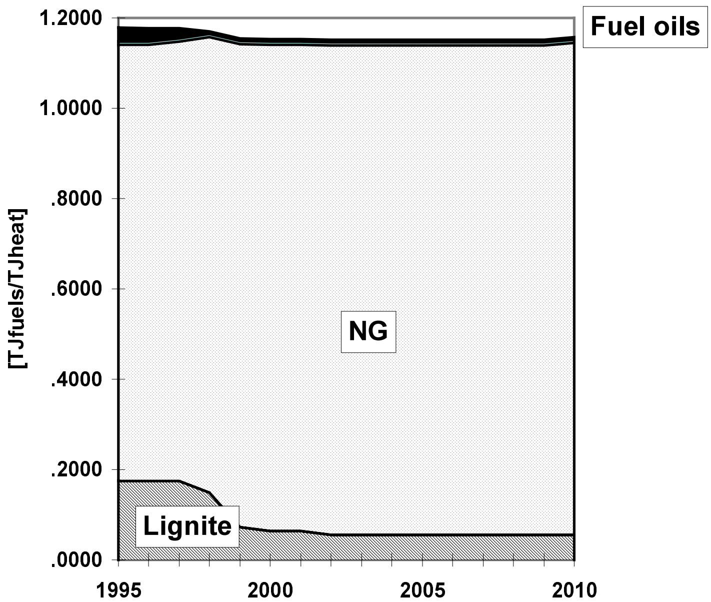


Figure A2 4. Impact of emission standards on the heat rate of individual fuels in non-industrial sectors



All above presented data have been used for modelling purposes in the sector of industrial energy sources, the sector of heat supply from local heating plants and for other remaining sources with thermal capacity > 5 MWt - except energy utilities. The fuel mix for base year has been established using available database and predicted future changes, where fuel mix is given by expansion plan and is the subject of modelling.

Fuel mix in technology has been considered to be stable for whole followed period and was split into the fuel mix in steel production and fuel mix in other technology units.

Expansion Plan Of Public Electricity Generation Utilities

The Slovak Electricity Power Plants , stock comp. (Slovenské elektrárne a.s. - SE a.s.) is the company with the majority of government as the stock holder. The following power and cogeneration plants are participating in the electricity generation as the main supplier [8]:

ENOA old power plant, which operates at present as CHP and will be retired and replaced with the new fluidised bed combustion boiler- CIRCOFLUID type. Lignite from the mine close to the power plant is used as a fuel. The power plant is connected to the regional electricity grid.

ENOB contains 4 dry bottom boilers, capacity of each unit is 110 MWe and the power plant is connected to the national electricity grid. Two boilers are retrofitted now by installation FGD (Waagner Biro). The fuel is domestic lignite from the mines in this locality. The future of next two boilers is subject of discussion now and their operation will strongly depend on installation of nuclear units in NPP Mochovce.

ENO Fluid is represented by above mentioned new fluidised bed boilers, replacing existing units of ENOA. Power plant will supply the heat too, similarly as ENOA.

EVO1 6 units with wet bottom boilers, using imported bituminous coal from Russia as a fuel. The capacity of each unit is 110MWe and power plant is connected to the national electricity grid. Two boilers have been retrofitted and in order to meet applied emission standards these units will be equipped with FGD technology. An additional 4 units will be the subject of repowering by installation of 4 fluidised bed combustion boilers.

EVO FGD 2 units of EVO1 equipped with wet scrubber FGD.

EVO Fluid repowering of 4 units of EVO1 to the fluidised bed combustion.

EVO2 6 units with the capacity 110 MWe combustion NG and HFO as alternatives.

EVO CC New combined cycle, dedicated to the electricity generation only with electricity generating efficiency of 50% .Location should be in Vojany or in other side in Slovakia.

TEKO Public CHP, managed by the SE a.s. Electricity supply is dispatched by the central dispatch station. The wet bottom boilers are equipped with gas burners to make possible the fuel switch from coal to gas in summer and gas to coal in winter. Repowering with combined cycle is considered.

TEKO CC public cogeneration TEKO repowered into combined cycle.

EBO1 Nuclear power plant 2 x 440MWe, will be retired.

EBO 2 Nuclear power plant 2 x 440MWe;

EMO 1 Nuclear power plant 2 x 440MWe in construction;

EMO 2 Nuclear power plant 2 x 440MWe in consideration;

HPP Present system of hydropower plants, including HPP Gab□íkovo;

Following table gives the results of expansion plan simulation modelling using the DECPAC (WASP based model of IAEA) and ENPEP(Balance modul) considering the concept of SE a.s.. This concept contains the low and high nuclear energy use scenario as well as future agreement with Hungary, according which some part of electricity from HPP Gabcikovo will be supplied to this country [3,4,10].

Table A2 10. Electricity production in SE a.s. for high and low nuclear energy use scenarios [GWh/year]

High nuclear scenario

	2000	**2005**	**2010**
EBO1	5300	0	0
EBO2	5400	5700	5700
EMO1	5300	5400	5700
EMO2	0	5300	5400
NPP total	16000	16400	16800
EVO1* [*1]	2400	3400	3400
EVO2	1300	1400	1400
ENO A [*2]	350	300	300
ENO PP [*3]	900	900	800
TEKO [*4]	500	1000	1000
EVO CC	0	0	3500
TPP total	5450	7000	10400

Low nuclear scenario

	2000	**2005**	**2010**
EBO1	5300	0	0
EBO2	5400	5700	5700
EMO1	5300	5400	5700
EMO2	0	0	0
NPP total	16000	11100	11400
EVO1 [*1]	2400	3400	3400
EVO2	1300	1300	1400
ENO A [*2]	350	300	300
ENO PP [*3]	900	900	800
TEKO [*4]	500	900	900
EVO CC	0	3500	6500
TPP total	5450	10300	13300

HPP 1	2400	2600	3100
HPP G	1450	1450	1450
HPP	3850	4050	4550
SE, a.s.	25300	27450	31750
NPP	16000	16400	16800
TPP	5450	7000	10400
HPP	3850	4050	4550
SE, a.s.	25300	27450	31750

HPP 1	2400	2600	3100
HPP G	1450	1450	1450
HPP	3850	4050	4550
SE, a.s.	25300	25450	29250
NPP	16000	11100	11400
TPP	5450	10300	13300
HPP	3850	4050	4550
SE, a.s.	25300	25450	29250

1* Includes units before and after repowering and retrofit
2* Includes repowering of ENO A to fluidised bed combustion
3* Includes all units in ENO B, with and without FGD
4* Includes old cogeneration units and new combined cycle

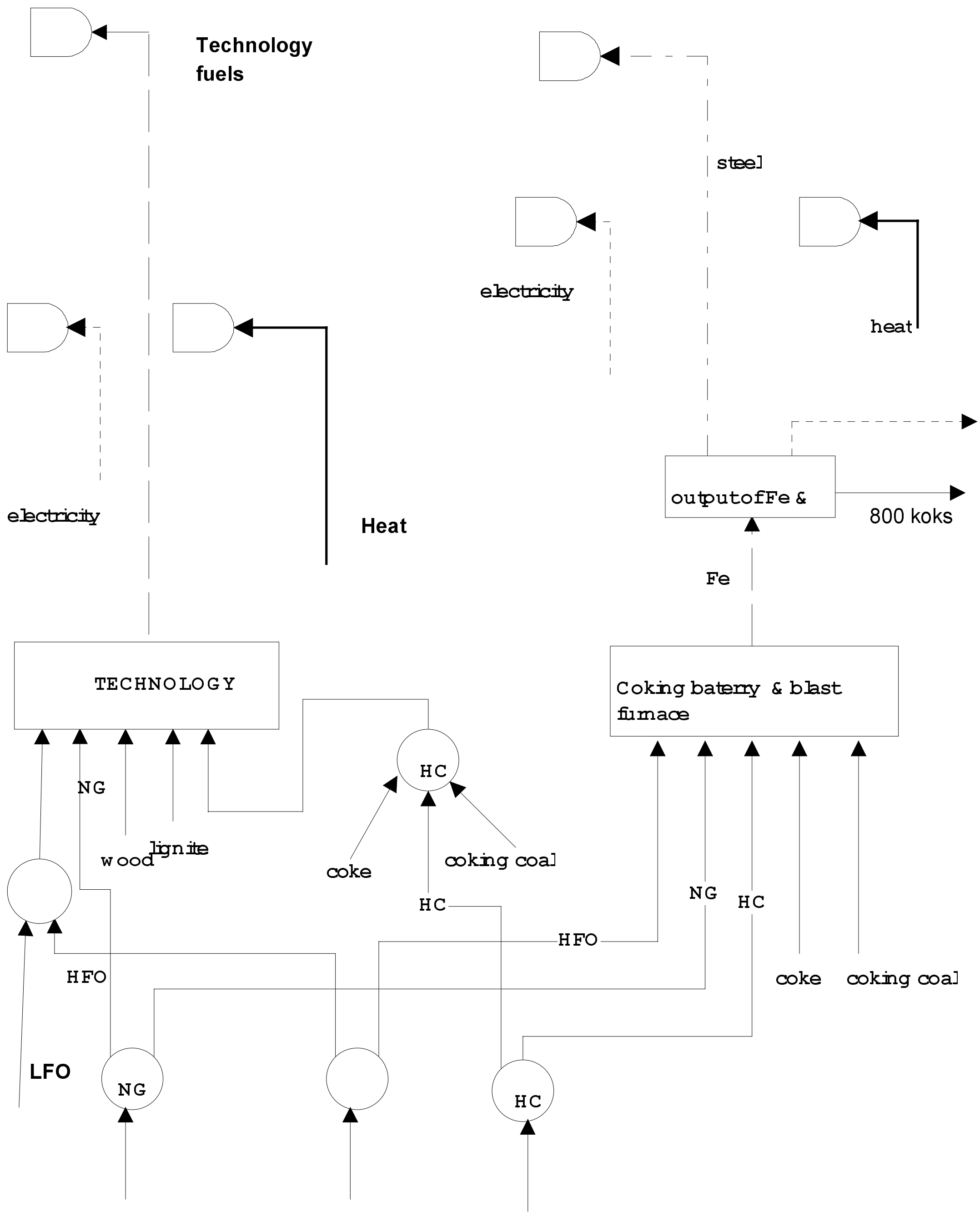
Final Energy Demand [30]

Industrial Sector

Energy demands in the industrial sector have been splitted into the consumption at steel production and consumption in other industry. The flowsheet of fuel split and energy demand in the industrial sector is given in Figure A2 5.

Figure A2 5. Fuel split and energy demand in industry

[30] See references 10 - 19



Final energy demands in industry are based on a GDP growth rate, considering the Autonomous Energy Efficiency Improvement (AEEI) during followed period. Nevertheless, AEEI is different for individual energy carriers and, therefore, different elasticity has been considered. In next table are given the data of assumed elasticity in case of heat, fuel and electricity demands in industry.

Table A2 11. Elasticity in the industrial sector

Energy demand	*Period*	*Elasticity*
Technology fuel	1996 - 2001	1

	2002 - 2010	decrease of 0.02/year
Industrial heat from CHP	1996 - 1997	0.8
	1998 - 2010	decrease of 0.01/year
Electricity	1996 - 1997	0.8
	1998	0.78
	1999 - 2010	decrease of 0.03/year

Energy demand in steel industry is very closed to the steel production growth rate [3]. Some technology improvements (continual casting, etc.) have been applied in last years and some additional investment, leading to different fuel split and impressive AEEI, have not been considered. The other case is investment in industrial CHP (combined cycle).

Residential Sector

The following table gives the data of final energy demands in the residential sector (Energy statistics, 1995).

Table A2 12. Energy consumption in residential sector

TJ/year	*Coal*	*Oil*	*Gas*	*Biomass*	*Electricity*	*Heat*	*Sum*
Heat	12425	932	31089	15	3958	13021	61441
Water heater	654	137	9715	1	3059	1860	15426
Appliances, Cooking	0	0	2375	0	10976	0	13351
Total	***13079***	***1069***	***43180***	***16***	***17993***	***14881***	***90217***

Source: Energy Statistics Data, Ministry of Economy of SR, 1995

A number of dwelling and its share is used as a base indicator in the residential sector (Data from Energy Agency, February 1998).

Table A2 13. Number of flats in dwellings and mansions

Low scenario				
	1995	***2000***	***2005***	***2010***
- in dwellings	885	908	936	970
- in Mansions	776	788	805	827
- Total	***1661***	***1696***	***1742***	***1797***
High scenario				
	1995	***2000***	***2005***	***2010***
- in dwellings	885	918	957	1003
- in Mansions	776	795	820	849
- Total	***1661***	***1712***	***1777***	***1852***

The split of flats and their AGR is given in following table:

Table A2 14. Split of flats

Year	***1995***	***2000***	***2005***	***2010***
Population	5368	5409	5420	5399
Low scenario				
Persons/dwell	3.2	3.2	3.1	3.0

Flats (share)				
- in dwellings	53.3%	53.5%	53.8%	54.0%
- in Mansions	46.7%	46.5%	46.2%	46.0%
- Total	100.0%	100.0%	100.0%	100.0%
- AGR mansions		***-0.1***	***-0.1***	***-0.1***
High scenario				
Persons/dwell	3.2	3.2	3.1	2.9
Flats (share)				
- in dwellings	53.3%	53.6%	53.9%	54.2%
- in Mansions	46.7%	46.4%	46.1%	45.8%
- Total	100.0%	100.0%	100.0%	100.0%
- AGR mansions		***-0.125***	***-0.125***	***-0.125***

Structural changes of flats are summarised in Table A2 15.

Table A2 15. New and old flats- low scenario

Year	***1995***	***2000***	***2005***	***2010***
Pull down of flats, depreciation		100 years		
- in dwellings		45	47	49
- in Mansions		39	40	41
- Total		***85***	***87***	***90***
New building (sum of 5 years)				
- in dwellings		68	75	83
- in Mansions		52	58	63
- Total		***119***	***133***	***145***
Old Buildings				
- in dwellings	885	840	793	744
- in Mansions	776	736	696	655
- Total	***1661***	***1576***	***1489***	***1399***

Table A2 16. New and old flats- high scenario

Year	***1995***	***2000***	***2005***	***2010***
Pull down of flats, depreciation		80 years		
- in dwellings		57	60	63
- in Mansions		50	51	53
- Total		***107***	***111***	***116***
New building (sum of 5 years)				
- in dwellings		90	99	108
- in Mansions		69	76	82
- Total		***158***	***175***	***191***
Old Buildings				
- in dwellings	885	828	768	705
- in Mansions	776	726	675	622
- Total	***1661***	***1554***	***1443***	***1327***

Energy demands on heating per flat have been calculated separately for old and new houses. AGR data of specific energy demands considering the increase of energy efficiency (insulation, metering, etc.) are presented in Table A2 17. For this AEEI we didn't consider increase in efficiency of boilers.

Table A2. 17 Annual growth rate of energy intensity AGR_{EI} [%]

Year	***2000***	***2005***	***2010***
Low scenario			
- in dwellings	-0.20	-0.20	-0.20
- in Mansions	-0.20	-0.20	-0.20
High scenario			
- in dwellings	-0.25	-0.25	-0.25
- in Mansions	-0.25	-0.25	-0.25

These data represent an annually renovation ratio by 2% of all old flats with supposed increase in efficiency by 10% per renovated flat. These data correspond to figures of former GDR.

Specific energy demands(SED) in TJ/flat have been calculated under formula:

$$SED_i = SED_{i-1} \times (AGR_{EI}/100 + 1)$$

Results are summarised in following table:

Table A2 18. Specific energy demand in old houses [TJ/flat]

Existing Flats	***1995***	***2000***	***2005***	***2010***
Low scenario				
- in dwellings	40	39.6	39.2	38.9
- in Mansions	34	33.2	32.8	32.5
High scenario				
- in dwellings	40	39.5	39.1	38.6
- in Mansions	34	33.1	32.7	32.3

For specific energy demand in new houses we have used data from the NSS of the Czech Republic:

Table A2 19. Specific energy demand in new houses.[TJ/flat]

New houses	***2000***	***2005***	***2010***
Low scenario			
- in dwellings	32.5	32.5	32.5
- in Mansions	27	27	27
High scenario			
- in dwellings	32.5	32.5	32.5
- in Mansions	27	27	27

Using the data of new and old houses and specific energy demand, the total energy demand has been calculated for heating system:

Table A2 20. Energy demand for heating

Year	***1995***	***2000***	***2005***	***2010***
Low scenario				
- in dwellings	35449	35498	35781	36267
- in Mansions	25992	25820	25809	25934
- Total	***61441***	***61318***	***61590***	***62201***
High scenario				
- in dwellings	35449	35652	36138	36868
- in Mansions	25992	25877	25954	26189
- Total	***61441***	***61529***	***62092***	***63057***

In next table are given assumed data of AGR for individual energy carriers' share at final consumption.

Table A2 21. AGR of energy carriers' share [%] on final heat demand in the residential sector

Year	***2000***	***2005***	***2010***
Low scenario			
Coal+Biomass	-1.8	-4.0	-10.9
Oil+LPG	7.7	7.8	7.8
Gas	13.7	13.7	13.7
District heat	-0.3	-0.3	-0.3
Electricity	11.8	11.8	11.8
High scenario			
Coal+Biomass	-2.0	-4.7	-14.7
Oil+LPG	7.7	7.8	7.8
Gas	14.7	14.7	14.7
District heat	-0.3	-0.3	-0.3
Electricity	12.8	12.8	12.8

Using this data as well as the average data of boilers' efficiency, the final demand and AGR of individual energy carriers have been calculated for:

- Coal & biomass combustion -by using above given AGR data and flat split in base year, the AGR of fuel consumption has been calculated;
- District heat - we have used the same way to calculate AGR;
- Oil & LPG AGR of 1 % was considered;
- Electricity heating AGR of 1% was considered;
- Natural Gas covered the remaining share of heat demand

Table A2 22. gives proposed data of individual energy carriers consumption for residential heating, as well as proposed efficiency at final heat generation:

Table A2 22. Energy carriers consumption, low scenario

	efficiency[%]	***1995***	***2000***	***2005***	***2010***
Coal+Biomass	75	12440	11588	9682	5612
Oil+LPG	88	932	941	951	960
Gas	88	31089	31632	32932	35893
District heat	100	13021	13124	13309	13559
Electricity	100	3958	3998	4038	4078
Total		***61441***	***61283***	***60912***	***60103***

Table A2 23. Energy carriers consumption, high scenario

	efficiency[%]	***1995***	***2000***	***2005***	***2010***
Coal+Biomass	75	12440	11596	9440	4450
Oil+LPG	88	932	941	951	960
Gas	88	31089	31093	32442	35964
District heat	100	13021	13243	13557	13941
Electricity	100	3958	3998	4038	4078
Total		***61441***	***60872***	***60429***	***59393***

A similar way of energy demand estimation has been applied in case of warm water preparation and cooking.

Table A2 24. Energy demand at hot water preparation

	1995	2000	2005	2010
Population	5368	5409	5420	5399
Households	1661	1696	1742	1797
Low scenario				
Energy demand for hot water				
- in TJ	15426	15575	15686	15747
- per Capita	2.9	2.9	2.9	2.9
- per Flat	9.3	9.2	9.2	9.1
AGR [%]				
- in TJ				
- per Capita		0	0	0
- per Flat		-0.1	-0.1	-0.1
- Share Capita		0.75	0.75	0.75
High scenario				
Energy demand for hot water				
- in TJ	15426	15613	15766	15872
- per Capita	2.9	2.9	2.9	2.9
- per Flat	9.3	9.2	9.2	9.1
AGR [%]				
- in TJ				
- per Capita		0	0	0
- per Flat		-0.1	-0.1	-0.1
- Share Capita		0.75	0.75	0.75

Table A2 25. AGR of energy carriers' share [%] on final heat demand in the residential sector (low and high scenario)

	2000	2005	2010
Coal+Biomass	-3.5	-4.8	-7.1
Oil+LPG	0	0	0
Gas	0.5	0.5	0.5
District heat	-1	-1	-1
Electricity	-0.3	-0.3	-0.3

Table A2 26. Consumption of energy carriers for warm water demand, low scenario

	efficiency[%]	1995	2000	2005	2010
Coal+Biomass	75	655	555	443	315
Oil+LPG	88	137	138	140	141
Gas	88	9715	9833	9945	10057
District heat	100	1860	1797	1746	1705
Electricity	100	3059	3089	3120	3151
Total		***15426***	***15413***	***15394***	***15370***

Table A2 27. Consumption of energy carriers for warm water demand, high scenario

	efficiency[%]	*1995*	*2000*	*2005*	*2010*
Coal+Biomass	75	655	560	451	323
Oil+LPG	88	137	138	140	141
Gas	88	9715	9812	9905	10001
District heat	100	1860	1812	1777	1750
Electricity	100	3059	3089	3120	3151
Total		***15426***	***15412***	***15392***	***15367***

In following table are given results of similar estimations of electricity and gas demand for the cooking:

Table A2 28. Demand on energy carriers for cooking and appliances use in household

	1995	*2000*	*2005*	*2010*
Low scenario				
Electricity	10976	13247	15074	16848
Gas	2375	2082	1872	1723
Total	***13351***	***15329***	***16946***	***18570***
High scenario				
Electricity	10976	13337	15685	18238
Gas	2375	2102	1861	1687
Total	***13351***	***15439***	***17547***	***19925***

Energy Consumption in the Non-industrial Sectors

The non-industrial sectors, according to the statistical categories used in SR, include the agriculture, services and commercial and other activities. Together with these sectors, fuel use of stationary consumers in the transportation sector has been considered in our balance as a part of the sector commercial & services. The AGR of individual energy carriers' consumption have been calculated using the AGR of GDP and assumed elasticity values.

Table A2 29. Annual growth rate of electricity for the agriculture

	1995	*2000*	*2005*	*2010*
Low scenario				
AGR GDP [%]		3.2	0.7	2.5
Elasticity		-0.2	-0.1	0.1
consumption [TJ]	3257	3154	3144	3182
AGR cons [%]		-0.6	-0.1	0.2
High scenario				
AGR GDP [%]		2.9	0.5	3.4
Elasticity		-0.2	-0.1	0.1
consumption [TJ]	3257	3164	3157	3210
AGR cons [%]		-0.6	0.0	0.3

Electricity consumption for heating has been calculated:

$$\boldsymbol{Cons_i = Cons_{i-1} \times ((1+AGR_{GDP}/100 \times Elasticity) + EID/100)}$$

where

EID - energy intensity decrease [%]

AGR_{GDP} - annual growth rate of GDP [%]

$Cons_i$ - consumption of electricity in followed year
$Cons_{i-1}$- consumption of electricity in previous year

Table A2 30. Electricity demand for heating in the sector of services & commercial

	1995	2000	2005	2010
Low scenario				
AGR GDP [%]		6.5	5.2	4.1
Elasticity		0.2	0.15	0.1
AGR heat [%]		1.3	0.8	0.4
Energy intensity decrease		-0.4	-0.4	-0.4
- Consumption [TJ]	4001.0	4180.0	4258.6	4262.6
High scenario				
AGR GDP [%]		8.5	7.1	5.8
Elasticity		0.2	0.15	0.1
AGR heat [%]		1.7	1.1	0.6
Energy intensity decrease		-0.5	-0.5	-0.5
- Consumption [TJ]	4001.0	4239.6	4361.6	4388.0

To quantify electricity consumption for appliances in this sector, the annual growth rate of energy intensity AGR_{EI} has been used and assumed data correspond to the IEA values. Consumption was calculated as follows:

$$Cons_i = Cons_{i-1} \times (1+AGR_{GDP}/100 \times Elasticity) \times (1+AGR_{EI}/100)$$

Table A2 31. Electricity demand for appliances in the sector of services & commercial

	1995	2000	2005	2010
Low scenario				
AGR_{GDP} [%]		6.5	5.2	4.1
Elasticity		0.6	0.5	0.5
AGR_{EI} [%]		-2.0	-1.8	-1.5
Consumption [TJ]	16546.0	18095.9	18784.3	19065.5
High scenario				
AGR_{GDP} [%]		8.5	7.1	5.8
Elasticity		0.6	0.5	0.5
AGR_{EI} [%]		-2.3	-2.0	-1.8
Consumption [TJ]	16546.0	18497.2	19583.1	20350.7

Heat demand for the non-industrial sector has been established using the GDP growth rate, assumed elasticity and decrease in energy intensity.

Table A2 32. Key indicators for heat demand estimation

	1995	2000	2005	2010
Low scenario				
GDP of non industrial sectors	[bil.SK]	[bil.SK]	[bil.SK]	[bil.SK]
Agriculture	27.6	32.3	33.4	37.7
Services	276.3	378.1	487.0	594.1
Other	40.2	56.7	68.3	81.1
Total	344.1	467.1	588.7	712.9

AGR$_{GDP}$ [%]		6.3%	4.7%	3.9%
Elasticity		0.2	0.15	0.1
EID [%]		-0.42%	-0.41%	-0.39%
Heat demand	7806	8141.6	8266.3	8267.9
High scenario				
GDP of non industrial sectors	[bil.SK]	[bil.SK]	[bil.SK]	[bil.SK]
Agriculture	27.6	31.8	32.6	38.5
Services	276.3	415.0	585.8	777.3
Other	40.2	52.0	49.4	59.7
Total	344.1	498.8	667.8	875.5
AGR$_{GDP}$ [%]		7.7%	6.0%	5.6%
Elasticity		0.2	0.15	0.1
EID [%]		-0.53%	-0.50%	-0.46%
Heat demand	7806	8209.1	8374.7	8414.4

Some share of energy sources in the non-industrial sectors represent a boilers with thermal capacity higher than 5MWt. Similarly, as in case of industrial boilers, share of coal consumption will decrease in these sources, due to replacement by gas. Data of heat demand estimation, splitted for individual fuels, are given in tables A2 33. and A2 34.

Table A2 33. Heat demand by fuels in the non-industrial sectors, low scenario

			1995	***2000***	***2005***	***2010***
Decrease in coal share			0	-1.8%	-4.0%	-10.9%
Lignite in sources >5MWt [TJ]			1124	548	419	419
Gas boilers	efficiency		0	90%	91%	92%
Fuels	TJ	□ [%]	Heat [TJ]	Heat [TJ]	Heat [TJ]	Heat [TJ]
Lignite	1892	75	1419	837	697	666
HC	3538	75	2653	2605	2500	2227
coke	834	75	626	614	589	525
briquettes	40	75	30	29	28	25
NG	26543	88	23358	30136	30815	30791
LPG	967	88	851	851	851	851
WOOD	137	75	103	103	103	103
LFO	299	80	239	239	239	239
DH	15507	100	15507	15507	15507	15507

Table A2 34. Heat demand by fuels in the non-industrial sectors,high scenario

			1995	***2000***	***2005***	***2010***
Decrease of coal share			0	-1.8%	-4.0%	-10.9%
Lignite in sources >%MWt [TJ]			1124	548	419	419
Gas boilers	efficiency		0	90%	92%	94%
Fuels	TJ	□ [%]	Heat [TJ]	Heat [TJ]	Heat [TJ]	Heat [TJ]
Lignite	1892	75	1419	837	697	666
HC	3538	75	2653	2605	2500	2227
coke	834	75	626	614	589	525
Briquettes	40	75	30	29	28	25
NG	26543	88	23358	30566	31155	31030
LPG	967	88	851	851	851	851
WOOD	137	75	103	103	103	103
LFO	299	80	239	239	239	239

DH	15507	100	15507	15507	15507	15507

For lighting the following elasticity and AGR have been considered:

Table A2 35. Electricity demand for lighting

	2000	**2005**	**2010**
Elasticity	0.75	0.7	0.6
AGR low	4.9	3.6	2.4
AGR high	6.4	5.0	3.5

Energy Demand in the Transportation Sector

In the transportation sector plays dominant role a road transport. Energy demand of road transport is based on the vehicle fleet, mileage and specific consumption of individual vehicle types. Present analysis was based upon previous results, listed in The Second National Communication on Climate Change in the SR,1997 [4], but also some new assumptions in a low and a high scenario have been adopted. In next tables are given aggregated results of these analyses:

Table A2 36. Personal vehicle fleet

	1995	**2000**	**2005**	**2010**
Gasoline				
< 1400 ccm	779700	777200	786500	766750
> 1400 ccm	106010	129710	172680	225830
> 2000 ccm	29960	30830	30200	31000
Total	915670	937740	989380	1023580
Diesel				
< 2000 ccm	22000	52000	92500	130000
> 2000 ccm	2800	5500	7100	7600
Total	24800	57500	99600	137600
LPG	258	299	347	402
Two Stroke Engine	51000	18000	0	0
Motorcycles	315200	285000	261000	236000
Total cars	991728	1013539	1089327	1161582
Population	5368	5409	5420	5399
Cars / 1000 Cap.	185	187	201	215
AGR		-0.07%	1.21%	1.42%

Table A2 37. Personal vehicle mileage [km/year/vehicle]

	1995	**2000**	**2005**	**2010**
Gasoline				
< 1400 ccm	8524	8845	9521	9907
> 1400 ccm	11668	12834	13528	13743
> 2000 ccm	20738	22414	27135	29221
Total	9288	9843	10758	11338
Diesel				
< 2000 ccm	19800	19800	22000	22000
> 2000 ccm	21000	21000	23000	23000
Total	19935	19915	22071	22055
LPG	20000	20000	25000	25000
Two Stroke Engine	6500	5500	4000	3000
Motorcycles	2931	3142	3174	3219

Table A2 38. Total mileage [mil.km/year]

	1995	***2000***	***2005***	***2010***
- Gasoline				
< 1400 ccm	6647	6874	7488	7596
> 1400 ccm	1237	1665	2336	3104
> 2000 ccm	621	691	819	906
Total	8505	9230	10643	11606
- Diesel				
< 2000 ccm	436	1030	2035	2860
> 2000 ccm	59	116	163	175
Total	494	1145	2198	3035
- LPG	5	6	9	10
- Two Stroke Engine	332	99	0	0
- Motorcycles	924	896	829	760
Total Cars	9336	10480	12850	14650

Table A2 39. Specific energy consumption [l/100km]

	1995	***2000***	***2005***	***2010***
Gasoline				
< 1400 ccm	7.5	7.5	7.7	7.8
> 1400 ccm	7.7	7.8	8.0	8.1
> 2000 ccm	8.7	8.7	8.9	9.0
Total	7.6	7.7	7.8	8.0
Diesel				
< 2000 ccm	6.7	6.7	6.7	6.7
> 2000 ccm	7.7	7.7	7.7	7.7
Total	6.8	6.8	6.8	6.8
LPG	8.8	8.8	8.8	8.8
Two Stroke Engine	10.1	10.1	10.1	10.1
Motorcycles	2.3	2.3	2.4	2.5

Table A2 40. Fuel demand for personal transport

	1995	***2000***	***2005***	***2010***
Gasoline	21297	23264	27281	30279
Diesel	1187	2741	5241	7218
LPG	37	43	62	71
Two Stroke	1071	320	0	0
Total	23591	26367	32584	37568

Table A2 41. Number of gasoline duty vehicles-freight transport

	1995	***2000***	***2005***	***2010***
Gasoline Duty Vehicles				
- Light	5100	9200	14500	22000
- Heavy	6300	3000	300	0
- Total	11400	12200	14800	22000
Diesel duty vehicles				
- Light	71500	75000	80000	84298
- 3.5 - 16 t	95000	105000	125000	150000

- >16 t	31100	31700	33000	35500
- Total	197600	211700	238000	269798
Bus				
bus SAD	4950	5100	5600	6100
bus MHD	2000	2150	2300	2500
other busses	5200	6400	7100	7600
Total	12150	13650	15000	16200

Table A2 42. Freight vehicle and bus mileage [km/year/vehicle]

	1995	***2000***	***2005***	***2010***
Gasoline Duty Vehicles				
- Light	13100	13600	14500	14500
- Heavy	10500	9000	9000	9000
- Total	11663	12469	14389	14500
Diesel duty vehicles				
- Light	13100	14000	16000	16000
- 3.5 - 16 t	22300	22500	27000	27000
- >16 t	22100	23000	25500	25500
- Total	18940	19564	23095	23366
Bus				
bus SAD	60000	60000	60000	60000
bus MHD	50000	50000	50000	50000
other busses	40000	40000	40000	40000
Total	49794	49048	49000	49074

Table A2 43. Total mileage of buses and freight vehicles [mil.km/year]

	1995	2000	2005	2010
Gasoline Duty Vehicles				
- Light	67	125	210	319
- Heavy	66	27	3	0
- Total	133	152	213	319
- AGR		0	0	0
Diesel duty vehicles				
- Light	937	1050	1280	1349
- 3.5 - 16 t	2119	2363	3375	4050
- >16 t	687	729	842	905
- Total	3742	4142	5497	6304
- AGR		0	0	0
Bus				
bus SAD	297	306	336	366
bus MHD	100	108	115	125
other busses	208	256	284	304
Total	605	670	735	795

Table A2 44. Specific fuel consumption

	1995	2000	2005	2010
Gasoline Duty Vehicles				
- Light	10.9	10.9	10.9	10.9
- Heavy	14.8	14.8	14.8	14.8
- Total	12.8	11.6	10.9	10.9
Diesel duty vehicles				
- Light	11.0	11.0	11.0	11.0
- 3.5 - 16 t	19.0	19.0	19.0	19.0
- >16 t	28.1	28.1	28.1	28.1
- Total	18.7	18.6	18.5	18.6
Bus				
bus SAD	30	30	30	30
bus MHD	40	40	40	40
other busses	30	30	30	30
Total	31.7	31.6	31.6	31.6

Table A2 45. Energy demand for freight transport [GJ]

	1995	2000	2005	2010
Gasoline	546	564	746	1112
Diesel	31323	34513	44001	50078

Table A2 46. Total energy demand in road transport

	1995	2000	2005	2010
Gasoline	21843	23828	28027	31391
Diesel	32510	37254	49242	57296
LPG	37	43	62	71
Two Stroke	1071	320	0	0
Gasoline total	22914	24148	28027	31391

Fuel consumption scenario, presented above, has been established from results of previous study and referred to low scenario. For a high scenario we have established following total fuel demand:

Table A2 47. Fuel demand at high scenario

	1995	*2000*	*2005*	*2010*
Gasoline	21843	24196	29337	33922
Diesel	32510	37838	51635	62228
LPG	37	43	65	78
Two Stroke	1071	325	0	0
gasoline total	22914	24521	29337	33922

Electricity demand in rail transport has been quantified, similarly as in case of other sectors, using annual growth rate of GDP for transportation sector (AGR_{GDP}), annual growth rate of energy intensity (AGR_{EI}) and AGR of electrification (AGR_{EL}).

$$Cons_i = Cons_{i-1} \times (1+AGR_{GDP}/100 \times Elasticity) \times (1+AGR_{EI}/100) \times (1 + AGR_{EL}/100)$$

Table A2 48. Electricity demand in transportation sector

	1995	*2000*	*2005*	*2010*
Low scenario				
AGR_{EL} [%]		***1.5***	***1.0***	***0.5***
AGR_{Ei} [%]		***-1.0***	***-1.3***	***-1.5***
AGR_{GDP} [%]		***-2.0***	***-0.5***	***1.5***
Consumption [TJ]	4320	4001	3851	3943
AGR_{Cons} [%]		-1.5	-0.8	0.5
High scenario				
AGR_{EL} [%]		***1.5***	***1.0***	***0.5***
AGR_{Ei} [%]		***-1.0***	***-1.3***	***-1.5***
AGR_{GDP} [%]		***-2.0***	***-0.5***	***1.5***
Consumption [TJ]	4320	4001	3851	3943
AGR_{Cons} [%]		-1.5	-0.8	0.5

Sensitivity Analysis Of Final Energy Demand In Industry

Sensitivity Analysis Of Energy Demand In Industry

Energy consumption consists of these demands:

- technology fuels
- industrial heat from CHP and HP (steam, hot water)
- electricity consumption (from grid and industrial CHP)

The industrial sector is characterised by the highest level of uncertainty, caused by following factors:

⇒ Industry restructuring;
⇒ autonomous energy efficiency improvement - AEEI;
⇒ Impact of new investment and new technology transfer;

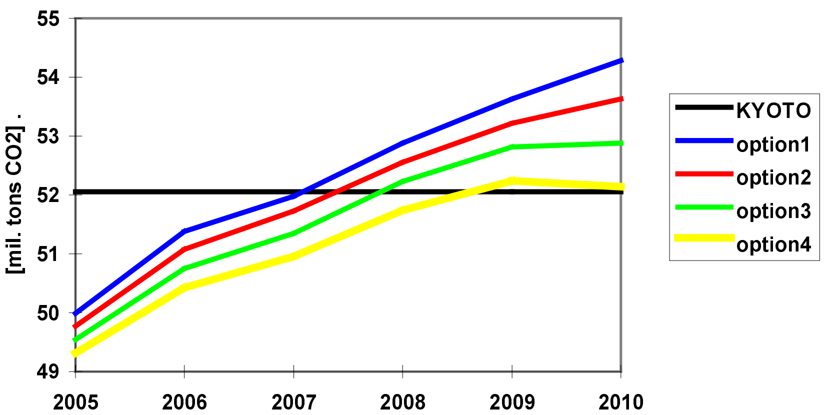
To analyse these impacts, the sensitivity analysis has been carried out providing 4 different options of elasticity level. These elasticity levels for energy demands in the industrial sector are summarised in following table:

Table A2 49. Elasticity considered at sensitivity analysis

Energy demand	***Period***	***Option1 Baseline***	***Option 2***	***Option 3***	***Option 4***
Technolog y fuel	1996 - 2001	1	1	1	1
	2002 - 2010	□e = - 0.02/year	□e = -0.03/year	□e = - 0.04/year	□e = - 0.05/year
Industrial heat	1996 - 1997	0.8	0.8	0.8	0.8
	1998 - 1999	□e = - 0.01/year	□e = - 0.01/year	□e = - 0.01/year	□e = - 0.01/year
	2000 - 2010	□e = - 0.02/year	□e = - 0.03/year	□e = - 0.04/year	□e = - 0.05/year
Electricity	1996 - 1997	0.8	0.8	0.8	0.8
	1998	0.78	0.78	0.78	0.78
	1888	0.75	0.75	0.75	0.75
	2000 - 2010	□e = - 0.03/year	□e = -0.04/year	□e = - 0.05/year	□e = - 0.06/year

In next figure are presented results of modelling, obtained by using scenario 8, e.g. scenario with high GDP growth rate and high nuclear energy use option as a baseline:

Figure A2 6. Sensitivity analysis of elasticity level impact



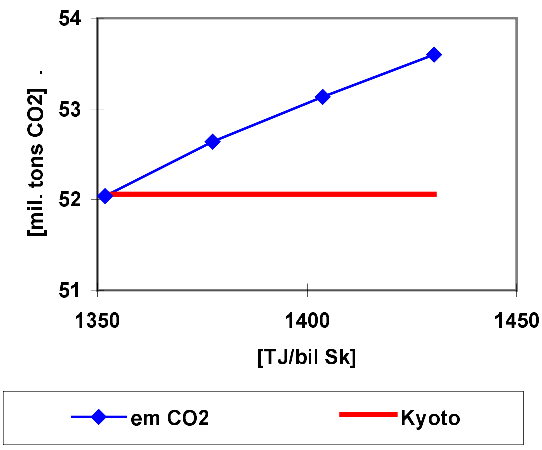
	Average EI [TJ/bil.Sk]	*Average 2008-2010 [thousand t CO_2]*	*Offset [thousand t CO_2]*
option 1	1430	53596	-1538
option 2	1404	53135	-1077
option 3	1378	52639	-580
option 4	1352	52039	20

As we see from figure above, the Kyoto requirements can be achieved for option 4. Different elasticity level of individual followed options determines the energy intensity of the industrial sector. In our analysis the energy consumption and GDP creation at steel production were excluded and energy intensity can be express as follows:

$$EI_{ind} = \frac{(FUEL + HEAT + ELECTRICITY}{(GDP_{IND} - GDP_{MET}*0.8)} \quad [TJ/bilSk]$$

GDP creation at steel production represents 80% of GDP creation in metallurgy sub-sector. In following figure and table are given data of relation between CO_2 emissions and energy intensity in the industrial sector:

Figure A2 7. CO_2 emission as a function of EI in industry



Using linear extrapolation, the needed energy intensity of the industrial sector to satisfy energy requirements is about 1367TJ/bil. Sk. This value represents AEEI by 5%, approximately.

Sensitivity Analysis of NPP Exploitation

For option with a high nuclear energy use we considered these levels of nuclear power plant installation:

Table A2 50. Capacity of nuclear power plants[MWe] at high nuclear scenarios

year	*2000*	*2005*	*2010*
EBO1	880	0	0
EBO2	880	880	880
EMO1	880	880	880
EMO2	0	880	880

Maximum of technically feasible potentials considers the 30 days of maintenance and fuel element change and forced outage by 5%. Two units of nuclear reactors, VVER type, with 2 x 440 MWe capacity, can produce following amount of electricity:

$$2 \times 440 \times 8.760 \times (365-30)/365 \times 0.95 = 4218 \text{ GWh/year}$$

For sensitivity analysis purposes we have considered these levels of technical nuclear capacity exploitation: 81% (baseline-scenario 8), 85%, 89%, 93%, 96%, 100%. In Figure A2 8. are illustrated curves of CO_2 emission scenario development for different levels of exploitation the nuclear potential. In Figure A2 9. is compared average emission level for the period 2008 - 2010 with the Kyoto requirements.

Figure A2 8. Emission scenarios for period 2005 - 2010 at different levels of nuclear potential exploitation

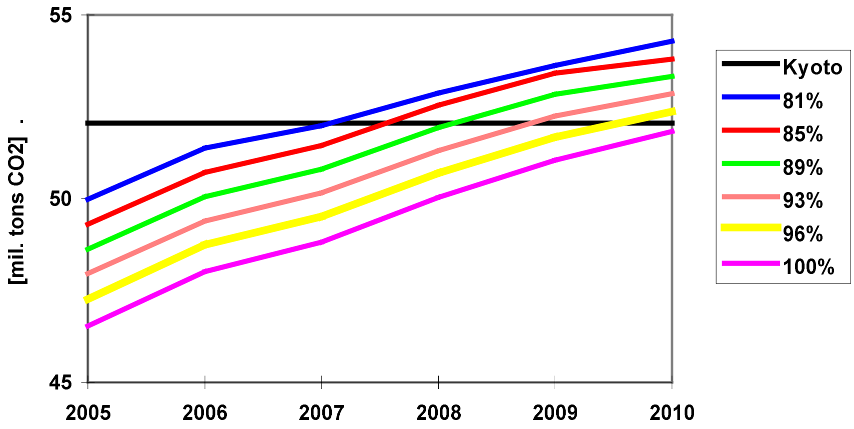
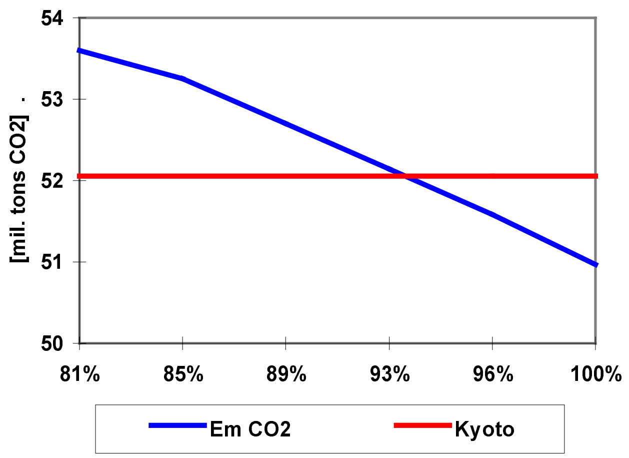


Figure A2 9. Comparison of average emission level for period 2008-2012 with the Kyoto requirements



NPPExp [%]	*Em CO_2 [thousands tons]*	*Kyoto [thousands tons]*	*Offset [thousands tons]*
81	53596	52390	-1538
85	53255	52390	-1197
89	52698	52390	-639
93	52139	52390	-81
96	51579	52390	479
100	50970	52390	1088

Baseline Scenario For Analysis Of JI Impacts

On the base of results from previous sensitivity analysis, baseline scenario for evaluation the JI impact has been selected using these assumptions:

- 5% AEEI comparing with a scenario 8 (*business as usual*, high nuclear, high GDP)
- Supposed levels of technically feasible nuclear potential exploitation were:

  2000 79%
  2005 90%
  2010 97%

New Energy Data For The Year 1996

Collected input data of energy consumption from Energy statistics and National Inventory are being presented in form given in following tables:

Table A2 51. Primary energy sources (PES) in 1996

Fuel type	Primary energy [TJ]. Production	Imports	Exports	Stock Changes	Consumption
Crude Oil	2970	221668	0	-5908	***218730***
Natural Gas Liquids	0	0	0	0	***0***
Gasoline	0	366	15235	89	***-14780***
Kerosene	0	0	2665	-22	***-2687***
Jet Kerosene	0	0	0	0	***0***
Diesel oil	0	0	38615	-378	***-38993***
Residual Light Fuel Oil	0	0	1171	106	***-1065***
Residual Heavy Fuel Oil	0	545	18787	810	***-17432***
LPG (propane-butane)	57	577	1601	56	***-911***
Naphtha	0	0	0	0	***0***
Bitumen	0	0	0	0	***0***
Lubricants	0	0	0	0	***0***
Petroleum Coke	0	0	0	0	***0***
Refinery Feedstocks	0	0	0	0	***0***
Other Oil	0	3	0	-51	***-48***
Total liquid fuels	***3027***	***223159***	***78074***	***-5298***	***142814***
anthracite	0	0	0	0	***0***
Coking Coal	0	77829	0	131	***77960***
Steam Coal	0	65048	226	-10629	***54193***
Lignite	42998	46627	410	-259	***88956***
Sub/bituminous coal	0	0	0	0	***0***
tar	0	0	0	0	***0***
BKB&Patent Fuel	0	121	0	-2	***119***
Coke	0	3995	2971	1689	***2713***
Solid fuels total	***42998***	***193620***	***3607***	***-9070***	***223941***
Natural Gas (Dry)	10224	222911	0	-603	232532
GP					
Coke gas					
Oven gas					
refinery gas					
Gaseous fuels total	***10224***	***222911***	***0***	***-603***	232532
Biomass solid	3184	0	0	-35	***3149***
Biomass liquid	0	0	0	0	***0***
Biomass total	***3184***	***0***	***0***	***-35***	3149
Total fossil fuels	***56249***	***639690***	***81681***	***-14971***	***599287***
Electricity	16320	15192	2513	0	***28999***
Heat	148519	0	0	0	***148519***
Total consumption	***224272***	***654882***	***84194***	***-15006***	***779954***

Table A2 52. Transformation and energy conversion in 1996

Transformation	Conversion fuel upgrade		Electricity Heating and power plants		Heat Heating and power plants		Heat Heating plants	
Fuel type	input	output	public	industrial	public	industrial	public	industrial
Crude Oil	218730	0	0	0	0	0	0	0
Natural Gas Liquids	0	0	0	0	0	0	0	0
Gasoline	0	35778	0	0	0	0	0	0
Kerosene	0	4508	0	0	0	0	0	0
Jet Kerosene	0	0	0	0	0	0	0	0
Diesel oil	0	73275	0	0	1	1	0	2
Resid. Light Fuel Oil	0	3371	0	0	0	6	0	383
Resid. Heavy Fuel Oil	0	43188	6470	1819	1562	9344	1752	3683
LPG-propane-butane	0	2456	0	0	0	0	0	0
Naphtha	0	0	0	0	0	0	0	0
Bitumen	0	0	0	0	0	0	0	0
Lubricants	0	0	0	0	0	0	0	0
Petroleum Coke	0	0	0	0	0	0	0	0
Refinery Feedstocks	0	0	0	0	0	0	0	0
Other Oil	0	25464	0	5604	0	14728	0	754
Total liquid	***218730***	***188040***	***6470***	***7423***	***1563***	***24079***	***1752***	***4822***
anthracite	0	0	0	0	0	0	0	0
Coking Coal	***62190***	0	0	0	0	0	0	0
Steam Coal	0	0	30037	5857	2110	10936	0	736
Lignite	0	0	26799	2874	11097	14167	826	4995
Sub/bituminous coal	0	0	0	0	0	0	0	0
tar	0	0	0	0	0	0	0	0
BKB&Patent Fuel	0	0	0	0	0	0	0	0
Coke	0	4664	0	0	0	0	189	44
Solid total	***62190***	***4664***	***56836***	***8731***	***13207***	***25103***	***1015***	***5775***
Natural Gas (Dry)	0	0	11723	1567	14805	9698	8488	20786
GP	0	0	0	0	0	0	0	0
Coke gas	0	11776	0	944	0	1500	0	32
Oven gas	0	15856	0	1355	0	2152	0	550
refinery gas	0	11175	0	1	0	8	0	2161
Gaseous total	***0***	***38807***	***11723***	***3867***	***14805***	***13358***	***8488***	***23529***
Biomass solid	0	0	0	154	0	1081	65	1616
Biomass liquid	0	0	0		0			0
Biomass total	***0***	***0***	***0***	***154***	***0***	***1081***	***65***	***1616***
Total fossil	***280920***	***231511***	***75029***	***20021***	***29575***	***62540***	***11255***	***34126.4***
Electricity	0	7468	7520	418	904	1670	0	0
Heat	0	19657	185420	17000	7586	5235	193	2688
Total consumption	***280920***	***258636***	***267969***	***37593***	***38065***	***70526***	***11513***	***38430.4***

Table A2 53. Loses, operational consumption, balance differences of 1996

Fuel type	Energy Heat	Energy Electricity	Loses in distr.net	Operational consumption	Balance differences	Final consumption
Crude Oil	***0***	***0***	0	0	0	***0***
Natural Gas Liquids	***0***	***0***	0	0	0	***0***
Gasoline	***0***	***0***	0	0	1129	***19869***
Kerosene	***0***	***0***	0	0	0	***1821***
Jet Kerosene	***0***	***0***	0	0	0	***0***
Diesel oil	***4***	***0***	0	0	0	***34278***
Residual Light Fuel Oil	***389***	***0***	0	0	0	***1917***
Residual Heavy Fuel Oil	***16341***	***8289***	0	0	1095	***31***
LPG (propane-butane)	***0***	***0***	0	0	0	***1545***
Naphtha	***0***	***0***	0	0	0	***0***
Bitumen	***0***	***0***	0	0	0	***0***
Lubricants	***0***	***0***	0	0	0	***0***
Petroleum Coke	***0***	***0***	0	0	0	***0***
Refinery Feedstocks	***0***	***0***	0	0	0	***0***
Other Oil	***15482***	***5604***	0	0	4315	***15***
Total liquid	***32216***	***13893***	***0***	***0***	***6539***	***59476***
anthracite	***0***	***0***	0	0	0	***0***
Coking Coal	***0***	***0***	0	0	0	***15770***
Steam Coal	***13782***	***35894***	22	0	0	***4495***
Lignite	***31085***	***29673***	64	0	0	***28134***
Sub/bituminous coal	***0***	***0***	0	0	0	***0***
tar	***0***	***0***	0	0	0	***0***
BKB&Patent Fuel	***0***	***0***	0	0	0	***119***
Coke	***233***	***0***	0	0	-27810	***34954***
Solid total	***45100***	***65567***	***86***	***0***	***-27810***	***83472***
Natural Gas (Dry)	***53777***	***13290***	***5785***	***0***	***135***	***159545***
GP	***0***	***0***	0	0	0	***0***
Coke gas	***1532***	***944***	225	0	1167	***7908***
Oven gas	***2702***	***1355***	822	0	3825	***7152***
refinery gas	***2169***	***1***	0	0	6779	***2226***
Gaseous	***60180***	***15590***	***6832***	***0***	***11906***	***176831***
Biomass solid	***2762***	***154***	0	0	0	***233***
Biomass liquid	***0***	***0***	0	0	0	***0***
Biomass total	***2762***	***154***	***0***	***0***	***0***	***233***
Total fossil	***137496***	***95050***	***6918***	***0***	***-9365***	***319779***
Electricity	***2574***	***7938***	5859	0	-65488	***85584***
Heat	***15702***	***202420***	7567	0	-172083	***114570***
Total consumption	***158534***	***305562***	***20344***	***0***	***-246936***	***520166***

Table A2 54. Final consumption - final energy uses in 1996

Fuel type	EUC total	Resorts by domestic industry	constructio n	methodology agriculture	transport	commerc ial	residenti al
Crude Oil	***0***	0	0	0	0	0	0
Natural Gas Liquids	***0***	0	0	0	0	0	0
Gasoline	***19869***	1952	450	385	173	4725	12184
Kerosene	***1821***	51	0	190	352	1228	0
Jet Kerosene	***0***	0	0	0	0	0	0
Diesel oil	***34278***	11809	2972	7631	7424	4142	300
Residual Light Fuel Oil	***1917***	251	356	289	27	994	0
Residual Heavy Fuel Oil	***31***	0	9	15	7	0	0
LPG (propane-butane)	***1545***	30	14	13	7	385	1096
Naphtha	***0***	0	0	0	0	0	0
Bitumen	***0***	0	0	0	0	0	0
Lubricants	***0***	0	0	0	0	0	0
Petroleum Coke	***0***	0	0	0	0	0	0
Refinery Feedstocks	***0***	0	0	0	0	0	0
Other Oil	***15***	0	0	6	9	0	0
Total liquid	***59476***	***14093***	***3801***	***8529***	***7999***	***11474***	***13580***
anthracite	***0***	0	0	0	0	0	0
Coking Coal	***15770***	9733	1	30	1	5978	27
Steam Coal	***4495***	3269	18	47	26	1061	74
Lignite	***28134***	1068	297	970	588	11667	13544
Sub/bituminous coal	***0***	0	0	0	0	0	0
tar	***0***	0	0	0	0	0	0
BKB&Patent Fuel	***119***	35	0	11	0	0	73
Coke	***34954***	32841	46	142	403	951	571
Solid total	***83472***	***46946***	***362***	***1200***	***1018***	***19657***	***14289***
Natural Gas (Dry)	***159545***	72239	1142	2067	141	32136	51820
GP	***0***	0	0	0	0	0	0
Coke gas	***7908***	7908	0	0	0	0	0
Oven gas	***7152***	7152	0	0	0	0	0
refinery gas	***2226***	2222	2	2	0	0	0
Gaseous	***176831***	***89521***	***1144***	***2069***	***141***	***32136***	***51820***
Biomass solid	***233***	0	2	147	7	44	33
Biomass liquid	***0***	0	0	0	0	0	0
Biomass total	***233***	***0***	***2***	***147***	***7***	***44***	***33***
Total fossil	***319779***	***150560***	***5307***	***11798***	***9158***	***63267***	***79689***
Electricity	***85584***	38264	1010	3073	3544	20069	19624
Heat	***114570***	83012	602	905	518	13944	15589
Total consumption	***520166***	***271836***	***6921***	***15923***	***13227***	***97324***	***114935***

Table A2 55. Estimation of CO_2 in year 1996;Carbon stored by energy statistics

	Consumption	EF C	Total C	stored C	Net Em C	oxid. C	Total C	***Total CO2***
Fuel	***[TJ]***	[kgC/GJ]	[Gg C]	[Gg C]	[Gg C]	-	[Gg C]	***[Gg/year]***
Crude Oil	***218730***	20.47	4477		4477	0.99	4433	***16253***
Natural Gas Liquids	***0***	15.2	0		0	0.99	0	***0***
Gasoline	***-14780***	19.73	-292		-292	0.99	-289	***-1059***
Kerosene	***-2687***	20.09	-54		-54	0.99	-53	***-196***
Jet Kerosene	***0***	19.5	0		0	0.99	0	***0***
Diesel oil	***-38993***	20.28	-791	0	-791	0.99	-783	***-2871***
Residual LFO	***-1065***	21.02	-22	488.9	-511	0.99	-506	***-1856***
Residual HFO	***-17432***	20.93	-365	0	-365	0.99	-361	***-1324***
LPG (prop.-but.)	***-911***	17.56	-16	0	-16	0.99	-16	***-58***
Naphtha	***0***	20	0	0	0	0.99	0	***0***
Bitumen	***0***	22	0	368.70	-369	0.99	-365	***-1338***
Lubricants	***0***	20	0	12.06	-12	0.99	-12	***-44***
Petroleum Coke	***0***	27.5	0		0	0.99	0	***0***
Refinery Feedstocks	***0***	20	0	191.25	-191	0.99	-189	***-694***
Other Oil	***-48***	20	-1		-1	0.99	-1	***-3***
Total liquid	***142814***	***20.56***	***2937***	***1061***	***1876***	***0.99***	***2640***	***6810***
anthracite	***0***	26.66	0		0	0.98	0	***0***
Coking Coal	***77960***	28.95	2257		2257	0.98	2212	***8110***
Steam Coal	***54193***	25.58	1386		1386	0.98	1359	***4981***
Lignite	***88956***	27.39	2437		2437	0.98	2388	***8755***
Sub/bituminous coal	***0***	26.2	0		0	0.98	0	***0***
tar	***0***	22.2	0	69.32	-69	0.98	-68	***-249***
BKB&Patent Fuel	***119***	25.16	3		3	0.98	3	***11***
Coke	***2713***	29.12	79		79	0.98	77	***284***
Solid total	***223941***	***27.51***	***6162***	***69***	***6092***	***0.98***	***5971***	***21892***
Natural Gas (Dry)	***232532***	***16.07***	***3737***	***64.40***	***3672***	***0.995***	***3654***	***13398***
Biomass solid	***3149***	27.59	87		87	0.98	85	***312***
Biomass liquid	***0***	20	0		0	0.99	0	***0***
Biomass total	***3149***	***27.59***	***87***	***0***	***87***	***0.98***	***85***	***312***
Total	***599287***	***21.418***	***12835***	***1195***	***11641***		***12265***	***42100***

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APPENDIX 3

METHODOLOGY AND INPUT DATA

In this appendix the simplified model of analysis for estimating GHG market potential is described, as well as the sensitivity analysis applied.

Simplified Model For Analysis

The simplified model analysis which INFRAS is elaborating is not a full scale economic model such as the macro-economic model GREEN, or the bottom-up model MARKAL in the following sense: It does not consider the economic repercussions of GHG-trading in terms of impacts on economic structure, GDP, capital and labour etc. (and its feedback onto GHG-emissions and MAC's). The simplified model is a partial equilibrium micro economic type model which uses fixed economic perspectives and works with the following inputs:

– the MAC curves[31] (as demand and as supply side offset market information) and
– the baseline CO_2-emission perspectives for each of the regions to be analysed[32].

With these inputs a (single) world market equilibrium price for CO_2 (GHG) offsets is estimated as an intermediary variable. Using it, estimates are then derived for the maximum theoretical potential for domestic and interregional trade volumes and associated monetary values. In practice the JI volume will build up slowly over time (see section 3.4.4). The less the market restrictions, the transaction costs and other market barriers, the faster this build up can be expected to develop.

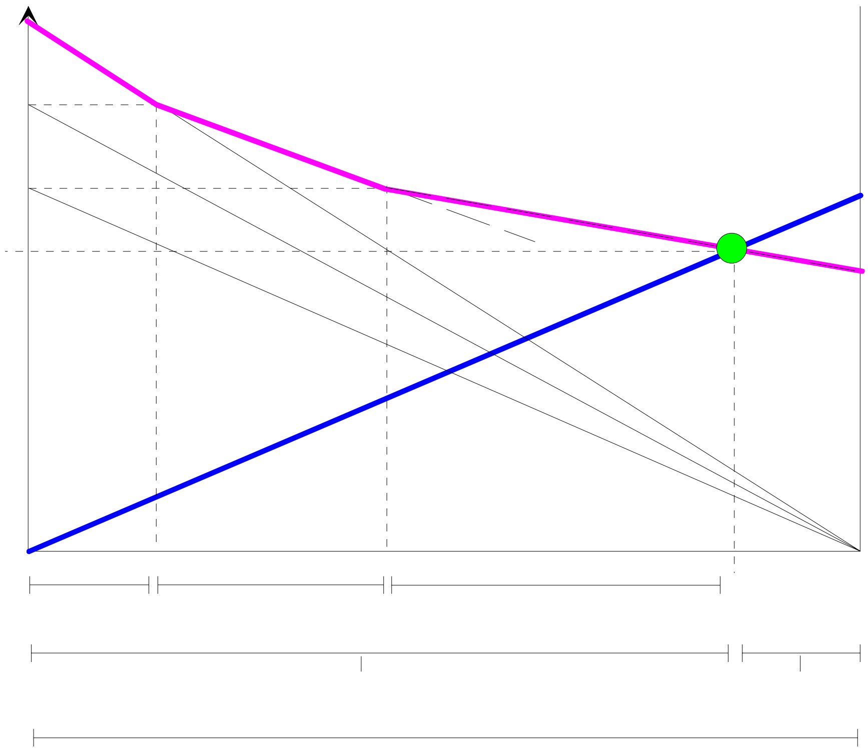
Market prices of carbon offsets, market values and trade volumes depend on the assumption about the market organisation and the type and structure of the offset market on the demand and supply side. Methodologically we assume that willingness to pay (WTP)) of the investor is less than, or equal to their domestic MACs, and that the willingness to sell (WTS) of the host countries is equal to, or higher than their respective MACs. Then market equilibrium in the carbon offsets market is given by the equality of marginal abatement cost (MAC) between the regions:

$$MAC_{\text{W-Europe}} = MAC_{\text{NA}} = MAC_{\text{Pacific}} = MAC_{\text{EIT}}$$

The demand curves of the buyers' countries are similar to the marginal abatement cost curves. To simulate the total demand of OECD countries and the total supply of EIT we can use aggregated demand and supply curves. Figure A3 1. illustrates the general approach.

[31] Modified by transaction cost assumptions
[32] Supply and demand curves for GHG offsets are treated as fixed, exogenous „inverse functions“ of each other.

Figure A3 1: The theoretical simulation of the CO_2 offsets market



The theoretical simulation of the CO_2 offsets market between Annex 1 countries follows a step-by-step approach. The aggregated MAC curves of the EIT group represent the supply curve (S): The aggregated MAC curves of the OECD countries are the basis for the aggregated demand (D) of buyer regions: PAC, WE and NA.
The static equilibrium price in the theoretical model (without crediting restrictions and transaction cost) is represented by point P. The total demand of EIT offsets by OECD countries is indicated by the distance between A and C. OECD countries will reduce the CO_2 emissions domestically from B to C. (This is true for the case where there are no limitations on the percentage of the commitments which a country can achieve by JI)

To simulate the demand of each OECD region it can be assumed that in the first step the region with the highest MACs and therefore the highest benefit and willingness to pay would invest in CO_2 offsets [33]. At the point where the price is similar to the highest MAC of the next region, the two regions together would buy offsets. The same procedure would be applied to the next investor region(s) with lower MACs yet.

If restrictions on offsets crediting OECD countries are specified, the analysis must be adapted: Buyer countries will have to fulfil their own domestic obligations first. If only 30% of the total obligations can be fulfilled by buying offsets from EIT countries, investor's country's MAC and demand curves will shift to a higher level. If there is a commitment for Western Europe of a 8% reduction of CO_2 emissions (compared to 1990 level), or -12% compared to

33 It is important to observe the following: For each region the MAC at the level of the last ton reduced domestically is relevant. For Western Europe, this level is -6% from baseline 2010, while for the Pacific region it is about -17% from baseline. This is why in figures 4 and 5 the PAC region has the highest willingness to pay (33 $/ton), eventhough in figure 2 the MAC curve of WE is above the curve for PAC.

the 2010 baseline, these countries must reduce emissions by about 8.4% domestically.[34] The MAC for the rest of the reductions needed (demand for offsets) will be higher. If the difference between the MACs of OECD and EIT are big enough, the willingness of OECD countries to pay will be higher than the marginal abatement costs in EIT countries. To estimate market prices and values of offsets under such conditions, further assumptions about the type of market competition and negotiation are necessary.

Theoretical Market Volume And Market Value

Assumptions On Market Organisation

As mentioned above the results of the model simulations depend on the assumptions made on the MAC curves, on the type of offset market, the degree of competition on the demand and supply side. E.g. for the static equilibrium analysis, as explained under section 3.4.2, the following are the main assumptions:

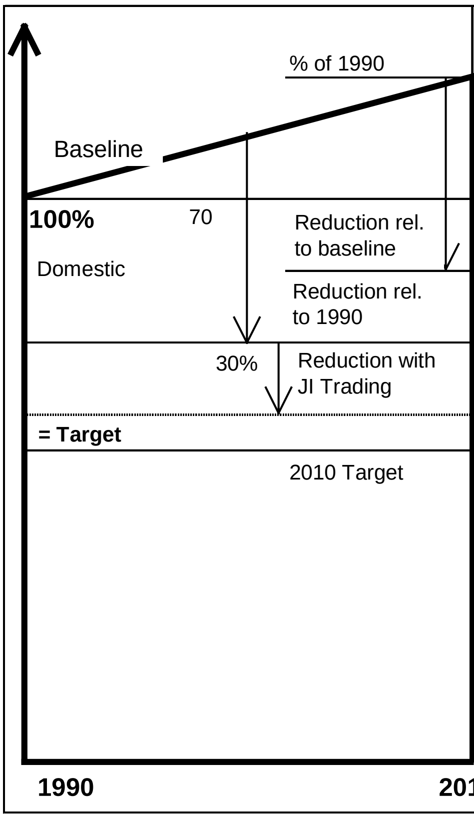
- Full competition on demand and supply side
- Equilibrium at fully developed markets is considered
- There is no single dominant player, neither on the demand nor on the supply side.
- If MAC's of buyer countries are significantly higher than MAC's of seller (host) countries, - for example due to trading restrictions - the market price is assumed to be the average of the two MAC curves at the point where JI credit trading can start.
- Transaction costs are 10% of the total project costs.
- Commitments: following the national commitments of COP 3 of Kyoto for period 2008 - 2012 (see table 3.2) .
- Crediting: 30% of total obligations ***compared to baseline*** can be fulfilled by offsets trading, 70% must be done domestically
- Offsets trading is restricted to Annex 1 countries: EIT's with OECD; there is no trade among OECD countries, and the JI participation of developing countries (Through CDM) is not considered

[34] 70% of a 12% reduction is 8.5%.

Scenario Results

Annex 1 countries shall reduce CO_2 emissions domestically until 2010 by 70% of their obligations. The remaining 30% can be traded. The following figure A3 2 summarises the scenario results for the four regions defined.

Figure A3 2: Calculations of the domestic and JI traded CO_2 reductions



	PAC	NA	WE	OECD	EIT
① Mio t/a	1710	6850	3510	12070	4370
② > 1990 in %	+ 16	+ 26%	+ 4%	+ 17%	+ 28%
③ 1990 Mio t/a	1470	5420	3370	10260	3410
④ - Mio t/a	-203	-1260	-273	-1736	-721
⑤ - % (2010)	-12%	-18%	-8%	-14%	-16%
⑥ - Mio t/a	37	170	-133	74	239
⑦ - % of 1990	3%	3%	-4%	1%	7%
⑧ - Mio t/a	-87	-540	-117	-744	-309
⑨ - % of 1990	-6%	-10%	-3%	-7%	-9%
⑩ Mio t	1420	5050	3120	9590	3340
Total reduction from 2010 in % baseline	-17%	-26%	-11%	-21%	-24%
in Mio t/a	-290	-1800	-390	-2480	-1030
MAC last ton domestic ($/t)	55	62	48	55	6
MAC first ton	33	37	29	33	4

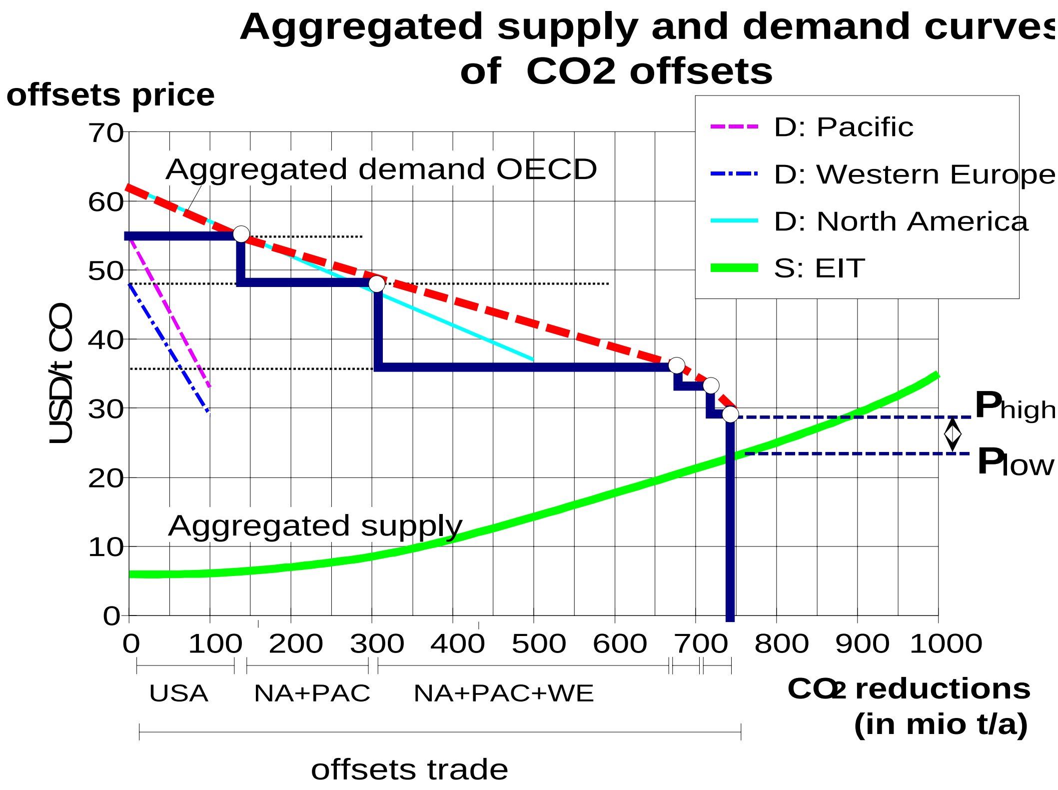
Calculations of the domestic and JI traded CO_2 reductions for the four regions, based on the Kyoto CO_2 reduction commitments and the assumption that 30% crediting share of total commitments compared to baseline can be achieved through JI.

Under these new conditions higher MACs are relevant (than if no, obligations for domestic reduction existed), namely those which prevail after fulfilling the domestic obligations. The EIT countries have by far the lowest MAC. If the EIT countries would sell all of the 744 mil t offsets which OECD countries are allowed to JI-trade, this would correspond to 18% (744 of total 4370 mil t) of the EIT's baseline in 2010. The marginal costs to reduce the last ton of the EIT's own obligations of 721 + 309 = 1030 mil t/a is estimated at about 6 $/ton. It is assumed that EIT countries do not act as investors in countries with even lower MAC's.

Figure A3 3 shows the international offset demand and supply curves, representing a model for estimating the theoretical potentials for offset markets between the three OECD demand regions NA, WE and PAC, and their supply region EIT. The variable plotted on the horizontal axis is the trade volume (in mil t/a after the complete fulfilment of the domestic reduction obligation part, 70% of the total obligations). On the vertical axis, the MACs are plotted, in $/t.

The aggregate EIT supply MAC curve S is self-explaining. The dotted curve AD sloping toward the right lower side is the „horizontally inverted" MAC curve of the three demand OECD demand regions, thus representing their demand curve. The stepped curve below this demand curve shows the max. willingness to pay for of each of the three OECD regions to buy offsets from EITs. (each of the levels corresponds to the MAC of the last ton domestically reduced in an OECD region, before trading is allowed). The actual trading price that can be expected in practice lies somewhere between the willingness to pay of the demand regions, and the supply curve of the EITs. According to the traditional static analysis there would be only one trading price, corresponding to the point where the MACs of the demand and supply curves are equal. (This is an approximate model for the allowance trading situation). On the other hand, the dynamic analysis of the market development suggests that trades would first be realised with the region offering the highest prices. (In figure this is NA, with MACs of 55 $/t for the last domestic reduction, and therefore for the demand for offsets). If the demand and the supply curves to not cross within the volume of trading allowed, trading prices will be a result of negotiation.

Figure A3 3: Simulation of maximum potential for CO_2 offset market



D = Demand, S = Supply

Simulation of the max. potential CO_2 offset market if 30% of Annex 1 countries' reduction targets compared to baseline can be traded (sources: see Table 3.2) D= demand, S= supply

As illustrated in Figure A3 3, and on the basis of the JI framework assumptions made all OECD regions would buy offsets from EIT's. The market price realised would depend on different economic and political factors and it must be somewhere between the MAC of EIT (23 USD) and the marginal benefit of OECD (29 USD). Accordingly the total market value of offsets could vary between 17 and 22 bln USD per year. This amount includes transaction costs of about 2 bln USD. As a probable outcome a market value of 20 bln USD per year is assumed.

It is useful to put this results in relation to those of other model simulations. E.g. a simulation of Jepma (1997)[35] is based on a -10% commitment compared to 1990 or 3000 mio t CO2 in OECD. In this model 2000 mio t CO2 are assumed to be supplied by EIT countries at MACs of 40 USD/t CO2 for the last unit of a 50% reduction. Following this assumptions a JI credit market of 80 bln $ could emerge. Commitments of only 1200 mio t CO_2 would result in a market price of 30 USD and a market volume of 35 bln USD/a.
It seems that these model results of Jepma correspond quit well to our results above. In our calculations (with the 70% to 30% restriction) we estimate a JI trade potential of 744 mio t/a, at an estimated price of around 25 USD, leading to a potential financial value of 18 bln USD/a. Other comparisons can be made to the simulations by the OECD GREEN Model. Assuming a stabilization commitment of OECD countries until 2020 compared to 1990 and a world-wide TCEE regime (trade in carbon emission entitlements) the equilibrium market price of TCEE was estimated by the GREEN model to be 4 USD / t CO2 (OECD MAC = 18 USD / t CO2) and trade in TCEE would grow to 10 bln USD per year (see ECON 1/97).

35 See Jepma J. (1997) in: JIQ - Joint Implementation Quarterly Vol. 3, No. 4, Dez. 1997.

Sensitivity Analysis

The sensitivity analysis were carried out in order to follow the impact of the different uncertainties on the offset market volume and cost and MAC. These uncertainties are mainly due the different assumptions of MACs and share of tradable reductions commitments. Table A3 1shows the simulation results depending on the assumed level of MACs. While, effectively it is the uncertainty in the ***difference in MACs*** between buyers and sellers, in the following analysis we look at variations only of the MACs on the demand side. (It can be assumed that they are uncertainties in the difference between EIT and OECD)

Table A3 1: Results of scenarios based on low and high MACs

a) MAC assumptions

	Offset trade			***MAC of last unit reduced domestically***			***MAC of first unit traded with JI***		
	Scenario			Scenario			Scenario		
	Low	Med	High	Low	Med	High	Low	Med	High
	mio t	mio t	mio t	USD/t	USD/t	USD/t	USD/t	USD/t	USD/t
PAC	105			41	55	80	25	33	80
WE	117			25	48	70	17	29	70
NA	310	540	540	17	62	110	13	37	110

b) Market results

	Market price			***Financial flow***			***Rent***		
	Scenario			Scenario			Scenario		
	Low	Med	High	Low	Med	High	Low	Med	High
	$	$	$	bln $	bln $	bln $	bln $	bln $	bln $
PAC	10	26	42	1.0	2.7	4.2	2.4	1.9	2.4
WE	10	26	42	1.2	3.0	4.6	1.3	1.5	1.8
NA	10	26	42	5.4	14	22	2.7	13	26
Total OECD	10	26	42	7.6	20	31	5.4	17	30
EIT	10	26	42	-7.6	-20	-31	2.6	8.5	12

The market price varies under different MAC assumptions between 10 and 42 USD/t CO_2. If the OECD MACs are lower than in den medium case expected, the market volume would be reduced from 20 to about 8 bln. USD per year. Meanwhile Western Europe and the Pacific region are able to buy all tradable offsets, MACs in North America are too low to allow for a profit from buying more credits than 310 mio t CO_2. Therefore the consumer rents of OECD decreases to some 5.4 bln. USD/a. and the producer rent of EITs to 2.6 bln. USD/a.

In the high OECD MAC-scenario the financial flows rise to more than 30 bln USD. We expect an OECD consumer rent of 30 bln. and a EIT producer rent of up to 12 bln. USD/a.

The scenario analysed in detail is based on a 30% share of commitments for which trade in form of Joint Implementation is allowed.

APPENDIX 4

Slovak Republic as one of the candidate of EU membership harmonises its legislation and policy with the other members of European Community.

Strategy And Policies Adopted

- ***Strategy, Principles and Priorities of the Governmental Policy***

This document has been approved by decision of the Slovak Government No. 619 from September 7,1993 and the decision of the National Council of the Slovak Republic No. 339 of November 18, 1993. This material determines the priorities of the state environmental policy and formulates the long-term (strategic), medium-term and short-term objectives. The short term strategy explicitly includes the program of greenhouse gases mitigation in the period of the years 2000 - 2010.

- ***Energy Strategy and Policy of the Slovak Republic up to the year 2005***

This document has been approved by decision of the Slovak Government No. 562/1993.The strategic goal of energy policy is to provide all consumers with fuels and energy. At the same time energy should be produced with the minimum price and with minimum impact on the environment. From an ecological point of view, the energy policy is aimed to the environmental improvement and reduction of contaminating substances emissions in compliance with the Slovak legislation and international commitments.

- ***Strategy and Policy of Forestry Development in the Slovak Republic***

This document has been approved by decision of the Slovak Government No.8 of January 12, 1993. One of the strategic goals of forestry development in Slovakia is to preserve forests, i.e. to maintain and gradually increase the afforested area and forestry as an important contributor to the ecological balance and landscape stability.

- ***Waste Management Program in the Slovak Republic***

This document has been approved by decision of the Slovak Government No.500 of July 13, 1993. The waste management program objective is to minimise the environmental risks (waste disposal, the development of managed landfills system, incinerators, recycling and separate waste collection).

- ***Principles of Agricultural Policy***

This document has been approved by decision of the National Council of the Slovak Republic of July 12, 1993. The adopted policy is concentrated on the fundamental measures to ensure ecologization of agricultural production, including rational consumption of fertilisers and the trends of further agricultural development.

Legislation

General Environment

- Act No. 17/1992 on Environment amended by Act No. 127/1994 on Environmental Impact Assessment.
- Act No. 127/1994 on Environmental Impact Assessment
- Act No. 140/1961 - Penal Code
- Act No. 248/1994 - Civil Code

Environmental Administration

- Act No. 347/1990 on Organisation of the Ministries and Other Central State Administration Authorities of the Slovak Republic as amended
- Act No. 595/1990 on Environmental State Administration as amended
- Act No. 134/1992 on the State Administration of Air Protection amended by Act.No. 148/1994
- Act No. 494/1991 of the Slovak National Council on State Administration of the Waste Management as amended.

Air Protection

- Act No. 309/1991 on Protection of the Air Against Pollutants as amended
- Decree of Government of Slovak Republic No. 92/1996, to Act No 309/1991 on Protection of the Air Against Pollutants as amended
- Promulgation of the Ministry of the Environment of the Slovak Republic No.111/1993 on expert licensing in the field of air protection
- Promulgation of the Ministry of the Environment of the Slovak Republic No. 112/1993 on establishing the regions requiring special air protection, and on the operation of smog warning and regulation systems

Waste Management

- Act No. 238/1991 on Waste
- Decree of the Slovak Government No. 605 /1992 on Keeping Evidence on Waste
- Decree of the Slovak Government No. 606 /1992 on Waste Treatment

Territorial Planning And Building Order

- Act No. 50/1976 on Territorial Planning and Building Order amended by Act No.103/1990 and Act No.262/1992
- Promulgation of the Federal Ministry of Technical and Investment Development No. 83/1976 on general technical requirements for construction amended by Promulgation No. 45/1979 of the same ministry and also by Promulgation of Ministry of the Environment of The Czech Republic and Slovak Commission for Environment No. 376/1992
- Promulgation of the Federal Ministry of Technical and Investment Development No. 84/1976 on the territorial planning and territorial planning documentation amended by Promulgation No. 337/1992 of the Federal Ministry of Technical and Investment Development
- Promulgation No. 85/1976 of the Federal Ministry of Technical and Investment Development on detailed provisions related to territorial proceedings and building order amended by Promulgation No. 378/1992 of the Federal Ministry of Technical and Investment Development and the Slovak Commission of Environment.
- Promulgation of the Federal Ministry of Technical and Investment Development No. 12/1978 on protection of forest land in territorial planning activities

- Regulation of the Ministry of Transport, Communications and Public Works No. 14/1994 of October 1, 1994 on procedures and technical conditions for additional insulation and removal of defects in residential buildings.
- Regulation of Ministry of Construction and Public Activities of the Slovak Republic No. 70/410/1996 of March 1, 1996 on additional residential building insulation and defects removing in this area.
- Act of the Slovak National Council No. 124/1996 on Government fund of housing development.
- Decree of Government of Slovak Republic No. 181/1996 on the programs of housing development.

Energy Management

- Act No. 79/1957 on Production, Distribution and Consumption of Electricity
- Act No. 67/1960 on Production, Distribution and Utilisation of Gaseous Fuels
- Act No. 89/1987 on Production, Distribution and Consumption of District Heat
- Act No. 88/1987 and No. 347/1990 on Energy Inspection
- Act No. 44/1988 on Protection and Use of Mineral Resources amended by Act No. 498/1991

Economic Instruments

- Act No. 128/1991 on State Fund for the Environment of the Slovak Republic amended by Act No. 311/1992 on Air Pollution Charges
- Promulgation of the Slovak Commission on Environment No. 176/1992 on conditions for providing and use of the funds from State Fund for the Environment of the Slovak Republic
- Act of the Slovak National Council No. 311/1992 on charges for air pollution
- Act of the Slovak National Council No. 309/1992 on charges for waste disposal
- Act No. 222/1992 on value-added tax
- Act No. 286/1992 on income tax amended by Act No. 326/1993
- Act No. 316/1993 on consumption tax for hydrocarbon fuels and oils
- Act No. 87/1994 on road tax

APPENDIX 5

This appendix describes the methodology used and results obtained by studying the individual measure's penetration impact on the abatement potential and abatement costs. This can provide the basis for estimation the individual measures penetration rate and time frame of this penetration.

Methodology Used

Next two approaches have been used at analysis of impact the individual measure's to the abatement level and abatement costs:

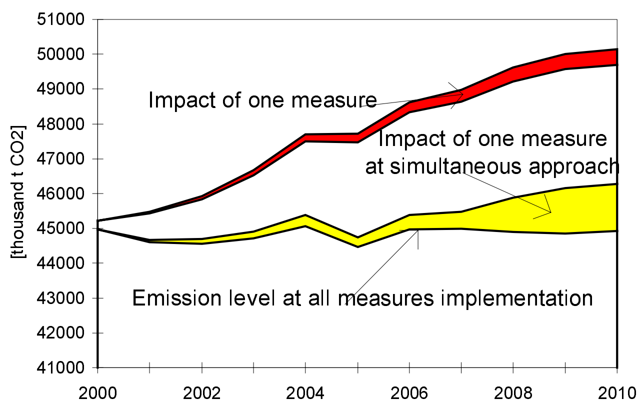
- First approach - penetration of one type of measure into the national energy supply/demand system only. The optimal penetration rate of individual measure type was estimated.
- Second approach - the impact of individual measures is followed at the simultaneous implementation of all considered measures.

In next figure are illustrated differences between above mentioned approaches.

The red area illustrates the impact of small HPP, followed by the first approach. The red field represents the emission decrease, if measures based on HPP will be implemented at estimated penetration rate, while other measures will not be applied. The impact of penetration rate was followed at the whole theoretical range (0 - 100%) to illustrate influence on the emission level. Nevertheless its selection for additional analysis took in attention the real values.

The second approach is illustrated by the yellow field. This field represents the increment of HPP implementation at the same estimated penetration rate, in the case, that all other considered measure are implemented too. The synergy effect can be observed in this case, although the simultaneous effect may be positive or negative, depending on the real situation.

Figure A5 1. Impact of mitigation measure at individual and simultaneous approach



Method Of Estimation The Individual Measure's Penetration Rate

For the first step of analysing possible effects of application some type of CO_2 mitigation option, the modelling using the ENPEP/BALANCE software module has been carried out. For modelling purposes the ratio of penetration some option was increased during selected time period and on the determined level. The difference of CO_2 emissions for baseline scenario[36] and followed mitigation scenario represents the impact of this option at given level of penetration into energy supply/demand system. The CO_2 abatement costs were calculated for the period at which the individual option penetrates into energy flowsheet. These cost calculations on the national level were based on next items:

- Change of fuel mix on the national level (increasing share of NG or renewable sources), fuel prices and their escalation;
- Changes of technology mix at electricity and heat generation in public supply system (public PP, regional CHP and local HP), where the different heat rate at different technology mix plays important role;
- Level of investment costs, cost escalation, life time of implemented technology;

In next table are presented data of important fuel prices and their escalation (data from Ministry of Economy,1998):

Table A5 1. Fuel and energy prices [US$/GJ]

Fuel/ energy	*1995*	*1996*	*1997*	*Escalation in next years [%]*
Lignite	2.6	2.6	2.6	3.38
Hard coal	3.1	3.1	3.1	2.36
Coke	4.2	4.3	4.4	2.36
Briquettes	4.2	4.3	4.4	2.36
NG	3.2	3.0	3.1	3.44
Nuclear fuel elements	0.5	0.5	0.5	1.00
Electricity import	11.1	11.4	11.7	2.70
LFO	4.5	4.5	4.5	3.20
HFO	2.0	2.0	2.8	3.20
Wood	1.5	1.5	1.5	0.00

Source: Energy Strategy and Policy of SR up to the year 2005, MoEC SR, Bratislava, October 1997;

The operation and maintenance costs were not included at this approach. Average abatement costs were based on the net present value (NPV) of investment costs for individual option and difference of NPV fuel cost between baseline and mitigation scenarios:

$$AAC = \left\{ \sum_{i=1}^{i=n} \left((\Delta FC_i + In_i)/(1+dr)^i \right) - Salvage/(1+dr)^{n+1} \right\} / \sum_{i=1}^{i=n} \Delta EMCO_{2,i}$$

Where:

AAC = average abatement costs [US$/t$CO_2$]
ΔFC_i = change of fuel costs on the national level [thous. US$]
In_i = investment costs in i-th year [thous. US$]
dr = discount rate
Salvage = total salvage of investment at the end followed period (in year 2011) [thous. US$]
$\Delta EMCO_{2,i}$ = change of emission [thous. t CO_2]

The AAC represents the ratio of abatement NPV and total CO_2 decrease in followed period. This calculation represents the simplified approach, focused on the most important component of costs, however some other factors, not considered in this calculation, can

[36] Baseline scenario for mitigation options is defined in Chapter 2 as high nuclear and GDP scenario, considering the utilisation of full feasible potential and additional 5% AEEI .

significantly change actual abatement costs. These items differ with the option type and will be discussed later. Also time frames for individual option's penetration into the energy supply/demand system are different.

Estimation Of Offset Potential And MAC At Simultaneous Approach

By simultaneous approach in the first step all considered measures are implemented at their estimated penetration rate. In next steps individual options are removed. The abatement potential and MAC of individual options were calculated as follows:

$$\boldsymbol{AbP_i = EM\ CO_{2,i} - EM\ CO_{2,total}}$$

Where:

AbP_i	Abatement potential of i-th option at simultaneous approach
$EM\ CO_{2,total}$	Emission of CO_2 in studied period, if all options are implemented at their estimated penetration rate [thous. t CO_2]
$EM\ CO_{2,i}$	Emission of CO_2 in observed period, if i-th option is not implemented [thous. t CO_2]

The MAC of individual option was calculated as:

$$\boldsymbol{MAC_i = 1000 \times (NPV_{total} - NPV_i)/ AbP_i}$$

Where:

MAC_i	Marginal abatement costs of i-th option [US$/t$CO_2$]
NPV_{total}	Net present value of costs for observed period, if all options are implemented at their estimated penetration rate [mil. US$]
NPV_i	Net present value of costs for studied period, if the i-th option is not implemented [mil. US$]

Penetration Rate And Abatement Costs Of Individual Measures

Measures Based On Fuel Switch

Fuel switch, preferably the switch of coal to NG, is one of the most frequent measures applied in framework of baseline scenarios to achieve emission standards of SO_2 and solid particles according to adopted environmental legislation. As far as for some sources this measure will not be applied mostly from financial reasons, this can create additional room for penetration this type of measure. Further penetration of gas is considered in period 2006 - 2010, e.g. in time schedule, when option applied in framework of baseline scenario are implemented. The fuel switch is considered for these sectors:

- Regional CHP
- Industrial CHP
- Final fuel use in sector of services and commercial
- Final fuel use in residential sector

This option considers the fuel switch of lignite, hard coal, coke, briquettes and heavy fuel oil to the NG. Increase of NG consumption can be expressed:

$$\boldsymbol{\Delta NG_{con} = \Delta SF_{con} \times \eta_{SF}/\eta_{NG}}$$

Where:

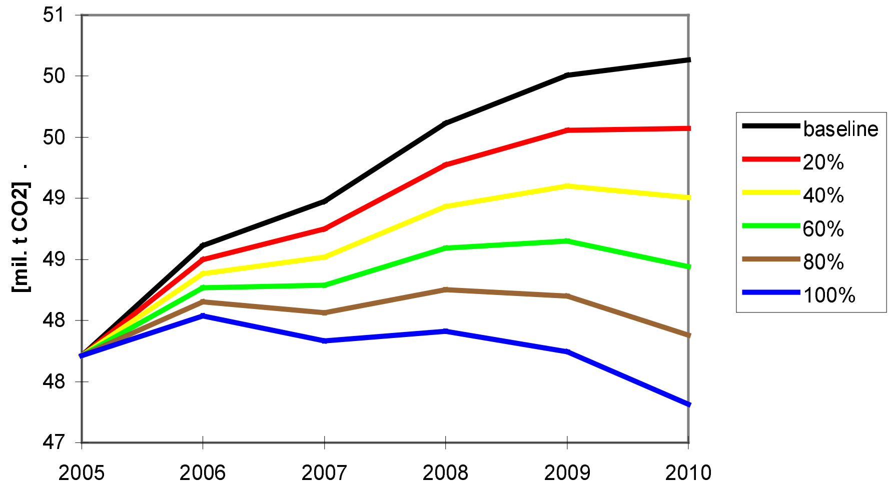
ΔNG_{con}	= increase of NG consumption [TJ/year]
ΔSF_{con}	= decrease of supplied fuel consumption [TJ/year]
η_{SF}	= thermal efficiency at supplied fuel combustion [%]
η_{NG}	= thermal efficiency at NG combustion [%]

The following table gives us the total number of CO_2 abatement:

Table A5 2. CO_2 abatement at fuel switch

Penetration rate [%]	**2006**	**2007**	**2008**	**2009**	**2010**
	ΔCO_2 [thous. t]	**ΔCO_2 [thous. t]**	**ΔCO_2 [thous. t]**	**ΔCO_2 [thous. t]**	**ΔCO_2 [thous. t]**
20	116	229	341	452	564
40	232	457	682	904	1127
60	348	686	1022	1356	1691
80	463	915	1363	1808	2254
100	579	1143	1704	2260	2818

Figure A5 2. CO_2 emission scenarios at NG penetration



Using described methodology, the abatement costs have been calculated on the base of following input data:

Sector	*Investment costs [thous. US$/MWt]*	*Life time [years]*	*Discount rate [%]*
Regional CHP	4.1	12	12
Local HP	67.7	12	12
Industrial CHP	67.7	12	12
Serv.&comm.	20.7	12	12
Residential	53.7	12	12

Source: data collected from various burner and boiler producers, expert estimations

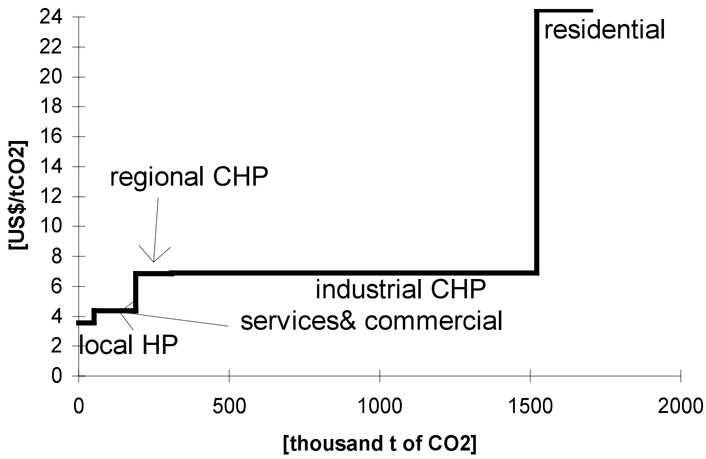
Investment costs were considered for base year 1995 at investment price escalation by 5%. Abatement costs were calculated for individual sectors and the impact of gas penetration depends on the fuel mix. In next table are given data of total CO_2 emission abatement for period 2006 - 2010 as well as abatement costs for individual sectors.

Table A5. 3 CO_2 abatement [thous.t CO_2] and abatement costs in period 2006 - 2010 for different sectors

Penetration [%]	*Regional CHP [thous.t CO_2]*	*DH local [thous.t CO_2]*	*Industrial[thous.t CO_2]*	*Comm&Serv[t hous.t CO_2]*	*Residential [thous.t CO_2]l*	*Total [thous.t CO_2]*
20	119	52	1212	138	180	1701
40	238	104	2425	276	360	3402
60	356	155	3637	414	540	5103
80	475	207	4850	552	720	6804
100	594	259	6062	690	900	8505
US$/tCO₂ [*1]	***6.8***	***3.5***	***6.9***	***4.4***	***24.5***	***8.4***

[*1] Average abatement cost is stable at whole range of penetration rate (20 - 40%);

Figure A5. 3 Cost curve at 20% penetration rate for period 2006 - 2010



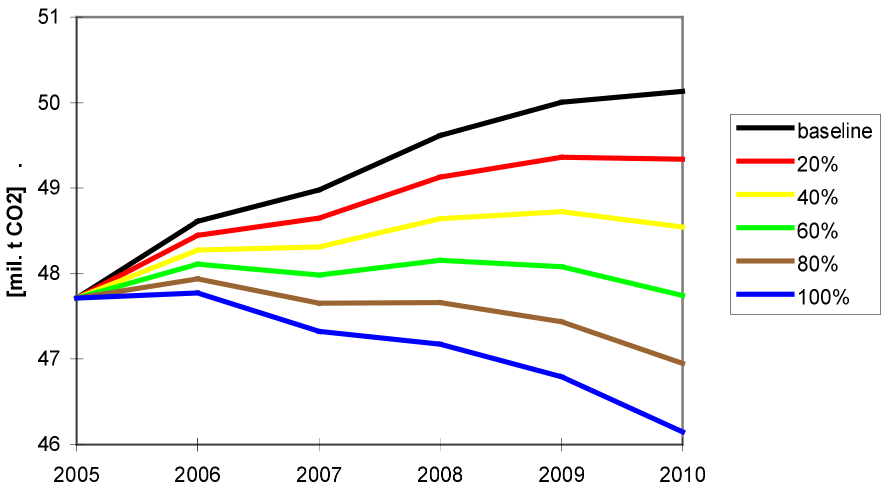
Abatement costs depend strongly on sectoral fuel mix. Presented values of abatement costs were calculated at aggregated approach on the national level. There have not been considered additional costs for construction of new gas distribution grid, if this will be necessary due to increasing share of gas demand. This cost item is site specific and local conditions could play very important role. In the case of residential sector financial requirements for connection to the gas grid has been included into investment costs. This was not considered for other sectors as well as their sources are connected to the national distribution grid and therefore additional costs would not be so significant. Calculations of abatement costs have been carried out on the base of uniform NG price, e.g. price used in industry and energy sector. Existing regulated gas price for residential sector is lower and it will give the different picture, but the price policy prepared for future (see Chapter 4) will shift the price relation on the actual economic level. Therefore the use of uniform gas price for all consumers will provide us with better information about real situation in period after the year 2000.

Other possibility of fuel switch can be represented by larger share of biomass penetration, preferably wood into the final fuel consumption. At this option the solid fuels are replaced by wood in similar manner as for NG. In following table are given data of the total number of CO_2 abatement:

Table A5 4. CO_2 abatement at fuel switch option- coal to wood

Penetration rate [%]	*2006*	*2007*	*2008*	*2009*	*2010*
	ΔCO_2 [thous. t]	*ΔCO_2 [thous. t]*	*ΔCO_2 [thous. t]*	*ΔCO_2 [thous. t]*	*ΔCO_2 [thous. t]*
20	169	330	488	643	796
40	337	660	976	1286	1593
60	506	990	1464	1928	2389
80	674	1320	1952	2571	3185
100	843	1650	2440	3214	3982

Figure A5 4. CO_2 emission scenarios for penetration of wood



Estimated investment costs in the year 1995 were 94500 US$/MWt and investment cost escalation by 5% was considered. The following table gives the total CO_2 abatement for period 2006 - 2010 as well as abatement costs for individual sectors.

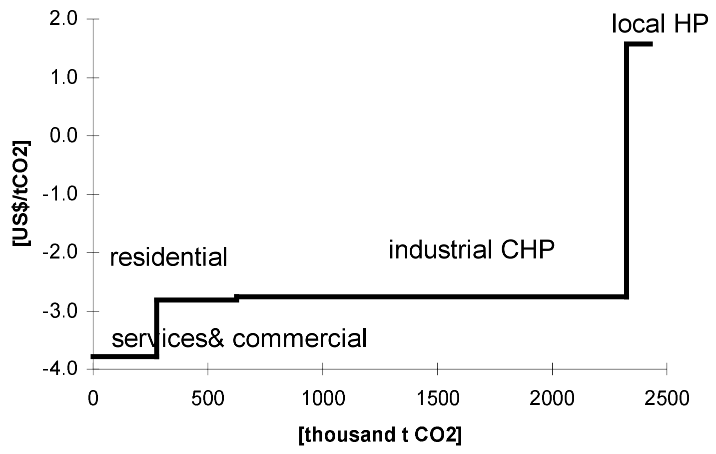
Table A5 5. CO_2 reduction [thous. t CO_2] and abatement costs for sectors in period 2006 - 2010

Penetration rate [%]	*DH local* □CO_2 *[thous. t]*	*Industrial* □CO_2 *[thous. t]*	*Comm&Serv* □CO_2 *[thous. t]*	*Residential* □CO_2 *[thous. t]*	*Total* □CO_2 *[thous. t]*
20	101	1699	276	350	2425
40	202	3398	552	699	4851
60	303	5096	828	1049	7276
80	405	6795	1104	1398	9702
100	506	8494	1380	1748	12127
US$/t$CO_2$ [*1]	***0.5***	***-2.8***	***-3.8***	***-2.8***	***-3***

[*1] Average abatement cost is stable at whole range of penetration rate (20 - 40%)

Similarly as in case of NG penetration, the abatement costs depend upon the initial fuel mix in individual sectors. In this case the sector of regional CHP was not considered for this option.

Figure A5 5. Cost curve at 20% penetration rate of wood for period 2006 - 2010



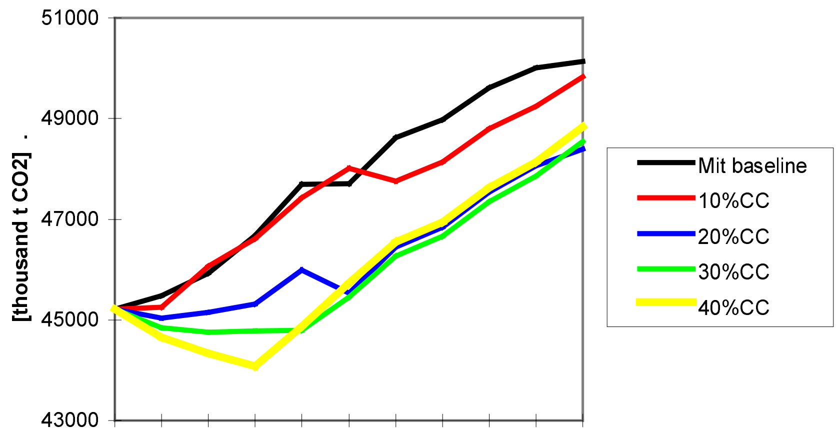
Measures Based On Increasing Share Of Cogeneration

This option considers the penetration of combined cycles into the industrial energy sector and into the sector of local district heating station. In our modelling the following penetration rate of combined cycles (CC) to the energy market have ben considered:

1) In industrial sector, the new installed combined cycle units (CC) will replace the share of 10%, 20%, 30% and 40% the electricity supplied from grid. This increase of additional autonomous electricity production was supposed to start in the year 2001 and in the year 2005 will achieve the determined level. Together with increasing electricity generation in new industrial cogeneration units with CC, the simultaneously produced heat replaces the heat supplied from existing industrial boilers.
2) For sector of heat supply from local DH plants, the same scenario has been applied, but the increasing share of new CC unit was rated to the heat supply from existing HP. The share of 10%, 20%, 30% and 40% of this heat is supplied from this new units and simultaneously generated electricity is supplied into the grid. The demand on the electricity production in public power plants declines by this way.

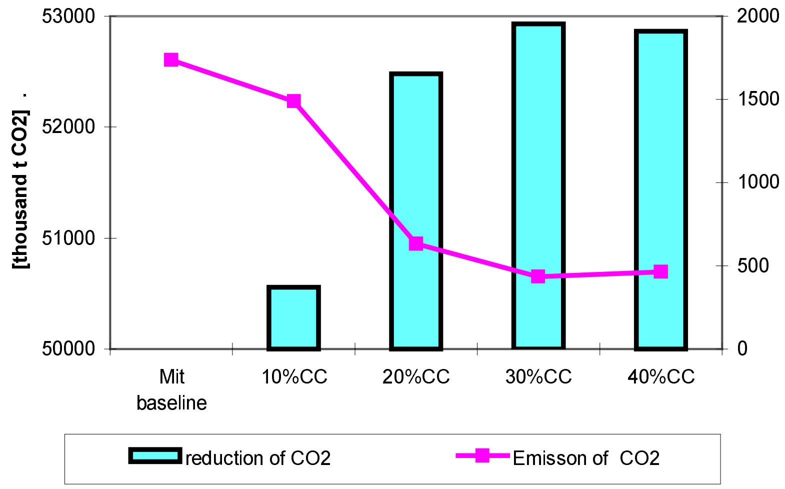
The following figure illustrates the impact of CC penetration to the CO_2 emission level:

Figure A5 6. CO_2 emission scenarios for different CC penetration rates



From figure A5 6. one can see that for increasing share of CC penetration, some maximum potential is achieved. We can also compare some average level of CO_2 emissions and average CO_2 decrease for the whole period of CC penetration:

Figure A5 7. Impact of CC penetration on the emission level and CO_2 credit



Average data for period 2001 -2010	*Emission of CO_2 [thous. t CO_2]*	*Reduction of CO_2 [thous. t CO_2]*
Mitigation baseline	52605	0
10%CC	52236	369
20%CC	50950	1655
30%CC	50653	1953
40%CC	50697	1909

We can see that for 30 % of CC penetration, the maximum potential is achieved.

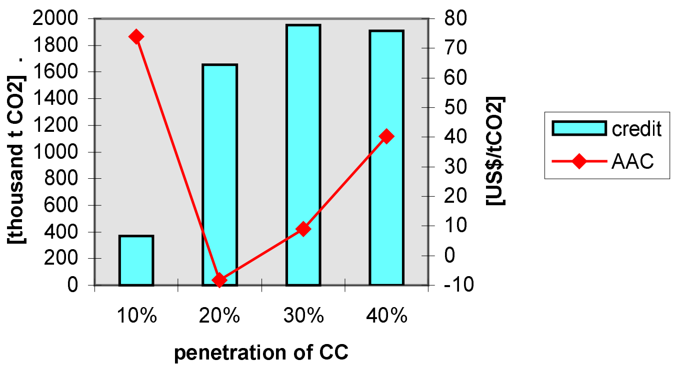
Next data of combined cycle investments costs were used for abatement cost calculations:

		Small CC	Ind CC
Investment	thousand Sk/MWe	12000	31200

Construction	15%	1800	4680
Other	5%	600	1560
Sk/US$		33.5	33.5
‘000'US$/MWe		430	1118

Source: Report INCHEM Bratislava 1993 :Conversion of aircraft engine to the stationary energy source;
Profing, s.r.o.: Achievement of Emission Standards Defined for New Sources of Air Pollution by the Existing Ones, MoE SR, Bratislava, April 1997;

Figure A5 8. CO_2 credit and abatement costs for different penetration rate of CC - average data for period 2001 - 2010



Penetration rate of CC[%]	*Credit [thous. t CO_2]*	*AAC [US$/t$CO_2$]*
10	369	73.9
20	1655	-8.3
30	1953	9.0
40	1909	40.3

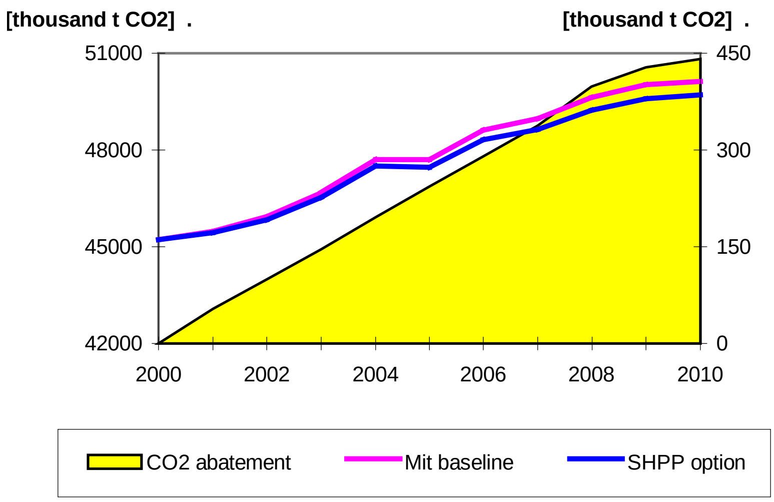
Response of public electricity supply system to electricity generation in combined cycles outside the public utility system will follow the loading order of individual power plants. Preferably the import of electricity is replaced togehter with the electricity produced with higher fuel and operational costs at lower penetration rate. Increasing of combined cycles penetration rate will bring the decrease of electricity generation in fossil power plants. It explains the both, abatement potential and average abatement costs jump between the 10 and 20% penetration rate. At extremely high CC penetration share we can replace also the part of electricity produced by the base load power plants, for example nuclear ones. This leads both to decrease in CO_2 abatement level and increase in abatement costs. Together with this it is not plausible for the public utilities to decrease the base load power plant utilisation. In case the independent electricity producer will not consume own produced electricity and excess of electricity will be supplied to the national grid, the actual economical relationships will depend on the purchase price. Present price relation is not motivated for such producers. Therefore the estimation of penetration share will strongly be influenced by future pricing policy, nevertheless the higher penetration rate than by 20% will probably not be exceed.

Penetration Of Renewable Energy Sources

From possible renewable energy carriers the biomass, hydropower and geothermal energy will play the most important role. The penetration of biomass (wood) has already been analysed as one of the fuel switch mitigation option.

The run-off hydropower plants represent the part of public electricity generating system. The additional potential of hydropower is represented by small hydropower plants, that can be operated by independent producers. The previous estimation of this potential was at 551.6 GWh[37] .For this mitigation option the step by step penetration of this potential to the electricity generating system has been considered in period 2001 - 2010. Similarly as in case of CC penetration the electricity produced by public power plants can be replaced in agreement with the economical loading order. In next figure and table are presented data of CO_2 emission scenario compared with the baseline scenario for considered period:

Figure A5 9. CO_2 emission scenario and abatement potential at small HPP penetration



Calculation of abatement costs was based on following input data:

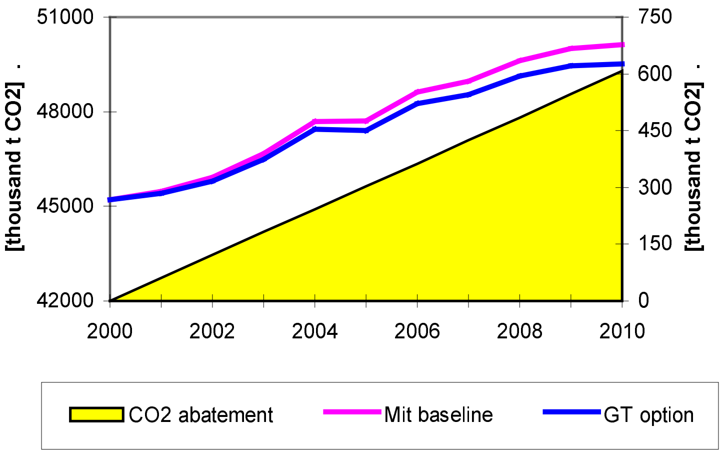
Investment cost escalation	5%
Discount rate	12%
Life time	50 years
Operation time	4160 h/year
Abatement costs	***-12.9 US$/t$CO_2$***

Actual operational time and investment costs are very site specific, however fuel cost change at the aggregated approach gives the more probable results than the project base approach. Negative abatement costs are primarily result of long life for technology main components.

Other type of renewable energy source is geothermal energy. Estimated potential of this energy is 7160 TJ in the year 2010[38] and continuous penetration of this source can lead to the replacement of heat sources (HP, CHP) in the sector of centralised district heat supply.

Figure A5 10. CO_2 emission scenario and reduction potential for penetration of geothermal heat

[37] Up-dated Energy Strategy and Policy .....
[38] Up-dated



Abatement cost estimation is predominantly influenced by investment costs and operational life time. On the base of expert estimation, the following input data from project pipeline have been used:

Investment costs	289 US$/MWt*1
Investment cost escalation	5%
Discount rate	12%
Life time	50 years
Operation time	5000 h/year
Abatement cost	***16.4 US$/tCO$_2$***

**1 Source: Experts estimation from various projects*

Demand Side Measures

At the demand side the measures focused on heat and warm water supply in residential sector can be concerned. The insulation and other measures in residential sectors can decrease energy demands on heating system by about 40% and specific heat demand on warm water supply by about 2GJ/dwell[39] Following input data have been used for purposes of our modelling:

Investment costs:

Retrofit of existing family houses	107 '000'Sk/dwell
Retrofit of existing mansions	80 '000'Sk/dwell
Retrofit of tap water supply system	11 '000'Sk/dwell

Source: VUPS NOVA, expert estimation on the base of data from various project of residential houses insulation.

Penetration rate:

1995 - 2000	2000 - 2005	2005 - 2010
3%	6%	8%

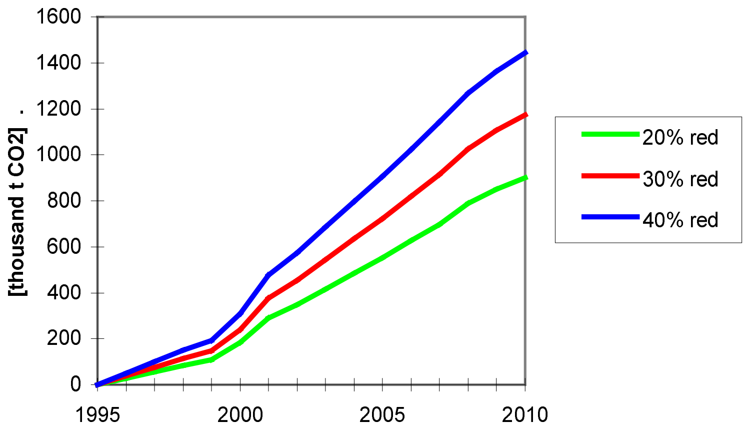
Efficiency improvement:

tap water supply : 2GJ/dwell
heating : 20%, 30%, 40% as alternatives.

In Figure A5 11. are presented curves of CO_2 reduction potential for implementation these measures at three different levels of efficiency improvement in heating/insulation system.

[39] Energy Agency Annual Report 1997 Bratislava

Figure A5 11. CO_2 emission scenario and reduction potential for demand side measures penetration



Although the different level of efficiency improvement has been considered at the same specific investment costs, the final number of abatement costs was not significantly influenced, as it is seen from next table:

Saving of heat [%]	20	30	40
Abatement [thous. tCO_2]	6411	8387	10486
AAC [US$/$tCO_2$]	-14.9	-15.1	-15.4

Sharing Of Offset Between The Host And Invest Side

The base assumption for modelling the emission offset sharing is:

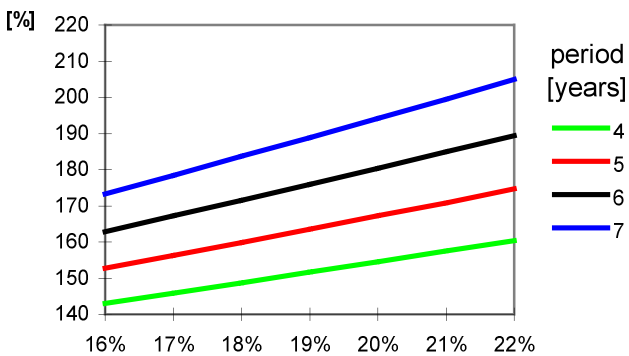
$$Share \times Offset \times WP = BC$$

Where:

Share	represents the share of offset needed to be subject of emission trading to overcome barriers for implementation of selected type of mitigation measure;
Offset	offset created by some type of measure [thousand t/year]
WP	investor willingness to pay for emission credit or allowance [US$/t$CO_2$];
BC	barrier costs, represent needed financial resources to implement some type of measure [thousand US$/year];

These barriers result preliminary from a lack of financial resources at project owner side. At present, the financial conditions to obtain loan for investment in energy sector are very hard - high interest rates in range of 16 - 22% approximately, short term for repayment in range about 4 - 7 years. Providing the payment will be at the end of every year, the investment costs will increase in range of about 140 - 205% ,as it may be seen from following figure:

Figure A5 12. Increase of investment costs for different level of interest rate and repayment period



For this condition, the MACs should be increased substantially and in the payment period of project implementation the negative cash-flow will be achieved. Therefore, in such case the project will not be implemented. Use of external financial resources to cover investment costs seems to be one the easiest way to overcome financial barriers. Using this assumption we can calculate the needed share of offset, which should be sold as credit or allowance to cover required investment costs. Above described condition is simplified approach only and in our model the mean value of offset share for determined period has been calculated. In our case we considered the period 1995 - 2010, used at emission scenario modelling (see Chapter 2). The share of ERUs (emission reduction units) needed to be sold as credit or allowance can be expressed as follows:

$$Share = \square\square\square \times \sum_{i=1995}^{i=2010} (Inv_i - Salv_{i,2011}) / \left(WP \times \sum_{i=1995}^{i=2010} Offset_i\right)$$

where:

Share	mean share of offset given to emission market;
□□	fraction of investment costs, that should be covered by incomes from emission trading;

Inv_i - investment applied in i-th year of followed period;
$Salv_{i,2011}$ Salvage from i-th investment in the year 2011;
WP Willingness to pay for credit, has been considered stable level for followed period;
Offset Offset created by applied type of measure in i-th year of followed period;

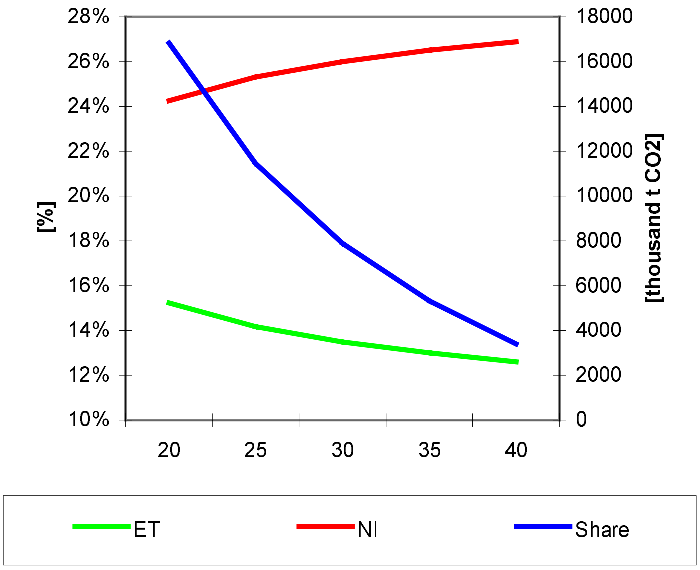
In this approach the investment cost and salvage have not been discounted as well as value of WP (willingness to pay) was considered to be uniform for the whole period. In following table are given results of analyses carried out with assumption, that willingness to pay for emission credit will be at the level of 25US$/t CO_2.

Table A5 6. Share of offset needed for credit or allowance trading

Type of measure	***Life time [years]***	***Investment***	***Salvage***	***Credit/***	***Offset***	***for NI***	***Share [%]***
		[thous. US$]		***[thous. t CO_2]***			
Industrial CC	25	3887454	3036042	34056	11151	-22905	305.4
Geothermal	50	618771	558582	2408	3546	1138	67.9
Small CC	25	445436	322802	4905	2786	-2120	176.1
Fuel switch	12	91919	85633	251	1136	885	22.1
DS measures	30	37857	28687	1514	8369	6855	18.1
Small HPP	50	2130	1923	8	6436	6428	0.1

As it is seen from table above, measure based on the combined cycle adoption doesn't seem to be very proper for emission trading. Increasing share of electricity generated by independent producers will replace in some instance only partly the electricity, generated from fossil fuels. For lower level of CC penetration, imported electricity will be primarily replaced and, for higher level of CC penetration, some part of non-fossil electricity will also be replaced. An impact of CC implementation on the CO_2 abatement is diminished by this way. Some further analyses ,in more details, will therefore needful in future. For different levels of WP values, the total amount of ERUs, needed to be sold as credit or allowance for covering investment costs, have been calculated , together with their share on total created offset:

Figure A5 12. Amount of emission decrease for national inventory (NI), for emission trading (ET) and its share on total emission offset (Share)



As we can see form the figure above, for increasing level of willingness to pay, the needed amount of ERU's for trading (ET-allowance or credit) decrease,so the higher share of ERU's could be saved for national inventory .